Chapter 8 - California Aqueduct
Section 1: Clifton Court to O'Neill Forebay

Potential Contaminant Source or Watershed Activity	Report Section	Water Quality Parameters									
		TDS/ Salts	Organic Carbon	Bromide	Pesticides	Nutrients	Pathogens	Trace Elements	Turbidity	T&O	Hydro-carbons
Recreation	8.1.3.1					○	○				
Wastewater Treatment/Facilities	8.1.3.2										
Urban Runoff	8.1.3.3	○	○		○	○	○	○	○	○	
Animal Populations	8.1.3.4	○	○			○	○		○	○	
Algal Blooms	8.1.3.5								○	◒	
Agricultural Activity	8.1.3.6	○	○		○	○		○		○	
Wind Erosion	8.1.3.7	○	○			○		○	◒		
Accidents/Spills	8.1.3.8							○		○	●
Groundwater Discharges	8.1.3.9										
Geologic Hazards	8.1.3.10	○		○							

Rating symbols:

● PCS is a highly significant threat to drinking water quality

◒ PCS is a medium threat to drinking water quality

⊙ PCS is a potential threat, but available information is inadequate to rate the threat

○ PCS is a minor threat to drinking water quality

Blank cells indicate PCS not a source of contaminant

Chapter 8 - California Aqueduct
Section 2: The O'Neill Forebay

Potential Contaminant Source or Watershed Activity	Report Section	Water Quality Parameters								
		TDS/ Salts	Organic Carbon	Bromide	Pesticides	Nutrients	Pathogens	Trace Elements	Turbidity	T&O
The Delta-Mendota Canal	8.2.3.1	◒	◒	◒	○	◒	⊙	○	◒	⊙
Recreation	8.2.3.2					○	◒			
Urban Runoff	8.2.3.3									
Agricultural Activities	8.2.3.4									
Animal Populations	8.2.3.5					◒	◒			
Accidents/Spills	8.2.3.6									
Fires	8.2.3.7	○							○	

Rating symbols:

● PCS is a highly significant threat to drinking water quality

◒ PCS is a medium threat to drinking water quality

⊙ PCS is a potential threat, but available information is inadequate to rate the threat

○ PCS is a minor threat to drinking water quality

Blank cells indicate PCS not a source of contaminant

Chapter 8 - California Aqueduct
Section 3: Outlet of O'Neill Forebay to Check 21 (Kettleman City): San Luis Canal

Potential Contaminant Source or Watershed Activity	Report Section	Water Quality Parameters									
		TDS/ Salts	Organic Carbon	Bromide	Pesticides	Nutrients	Pathogens	Trace Elements	Turbidity	T&O	Other
Floodwater Inflows	8.3.3.1	●	⊙	⊙	○	◒	⊙	●	●	○	● ^
Recreation	8.3.3.2						○				
Wastewater Treatment/Facilities	8.3.3.3	○	○			○	○		○	○	
Industrial Discharge to Land	8.3.3.4	○	○					○			
Industrial-site Stormwater Runoff	8.3.3.5	○	○		○	○		○			
Animal Populations	8.3.3.6	○	○			◒	◒				
Agricultural Activities	8.3.3.7				○						
Mines	8.3.3.8	○						○			◒ 1
Solid/Hazardous Waste Facilities	8.3.3.9	○			○	○		○			
Unauthorized Activity	8.3.3.10										
Transportation Corridors	8.3.3.11										○ 2
Accidents/Spills	8.3.3.12	○			○	○	○				○ 2
Groundwater Discharges	8.3.3.13	◒				○		◒			
Geologic Hazards	8.3.3.14	○	○	○	○	○	○	○	○	○	◒ 1
Population and General Urban Area Increase	8.3.3.15										

Rating symbols:

● PCS is a highly significant threat to drinking water quality

◒ PCS is a medium threat to drinking water quality

⊙ PCS is a potential threat, but available information is inadequate to rate the threat

○ PCS is a minor threat to drinking water quality

Blank cells indicate PCS not a source of contaminant

Notes:

1. Asbestos and mercury
2. Hydrocarbons

Chapter 8 - California Aqueduct
Section 4: Kettleman City to Kern River Intertie

Potential Contaminant Source or Watershed Activity	Report Section	Water Quality Parameters									
		TDS/ Salts	Organic Carbon	Bromide	Pesticides	Nutrients	Pathogens	Trace Elements	Turbidity	T&O	Hydro- carbons
Recreation	8.4.3.1						◒				
Wastewater Treatment/Facilities	8.4.3.2										
Floodwater Inflows	8.4.3.3										
Accidents/Spills	8.4.3.4										◒
Water-service Turnouts	8.4.3.5				○	○		○			

Rating symbols:

● PCS is a highly significant threat to drinking water quality

◒ PCS is a medium threat to drinking water quality

⊙ PCS is a potential threat, but available information is inadequate to rate the threat

○ PCS is a minor threat to drinking water quality

Blank cells indicate PCS not a source of contaminant

Chapter 8 - California Aqueduct
Section 5: Kern River Intertie to East/West Branch Bifurcation

Potential Contaminant Source or Watershed Activity	Report Section	Water Quality Parameters									
		TDS/ Salts	Organic Carbon	Bromide	Pesticides	Nutrients	Pathogens	Trace Elements	Turbidity	T&O	Other
Kern River Intertie	8.5.3.1				○	○	○	○	◒		
Groundwater Discharges	8.5.3.2	◒	○	○	○	○		◒ [1]			
Recreation	8.5.3.3						○				
Accidents/Spills	8.5.3.4										◒ [2]

Rating symbols:

- ● PCS is a highly significant threat to drinking water quality
- ◒ PCS is a medium threat to drinking water quality
- ⊙ PCS is a potential threat, but available information is inadequate to rate the threat
- ○ PCS is a minor threat to drinking water quality

Blank cells indicate PCS not a source of contaminant

Notes:

1. Arsenic
2. Hydrocarbons

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California Aqueduct

The Edmund G. Brown California Aqueduct is the State's largest and longest water conveyance system, stretching 440 miles from the Sacramento-San Joaquin Delta in the north to Lake Perris in Southern California. The aqueduct and its branches supply water for two-thirds of California's population and to irrigate about 1 million acres of farmland. Water is pumped from the Delta into the California Aqueduct at the Harvey O. Banks Delta Pumping Plant near Tracy. Because of its location in the southern Delta, the pumping plant receives water from both the Sacramento and San Joaquin rivers. Under normal hydrologic conditions the proportion of Sacramento and San Joaquin River water flowing in the aqueduct is approximately 70% and 30%, respectively. During wet years, the proportion of the San Joaquin water increases.

From the Banks Pumping Plant, water is transported via the California Aqueduct to the South Bay Aqueduct (see Chapter 5) and O'Neill Forebay. During winter months, water is pumped from O'Neill Forebay into San Luis Reservoir, a 2 million acre-feet (af) offstream storage reservoir (see Chapter 6). Water from the US Bureau of Reclamation's Delta-Mendota Canal (DMC) is also pumped into O'Neill Forebay for transfer into the reservoir. Commingling of the State Water Project (SWP) and DMC has important water quality impacts that are discussed later. From O'Neill Forebay, Delta water and San Luis Reservoir releases flow into and through a section of the California Aqueduct known as the San Luis Canal (SLC). Farther south the aqueduct intersects the Kern River Intertie (KRI) in Kern County near Bakersfield. Originally, the Kern River flowed into Tulare and Buena Vista lakes. The intertie was built to reclaim farmland, prevent flooding, and provide additional water to the SWP. Below the KRI, water is pumped over the Tehachapi Mountains. The California Aqueduct bifurcates at Gorman into the East Branch and the West Branch (see Chapter 10).

This chapter describes the water supply systems and facilities, potential contaminant sources (PCSs), and water quality of the main sections of the California Aqueduct from the Banks Pumping Plant to the bifurcation. For the purposes of this report, the California Aqueduct has been divided into 5 sections:

- Section 1: Clifton Court Forebay to O'Neill Forebay
- Section 2: The O'Neill Forebay
- Section 3: Outlet of O'Neill Forebay to Check 21 (the SLC)
- Section 4: Check 21 (Kettleman City) to KRI
- Section 5: KRI to East/West Branch Bifurcation

Section 3 is emphasized because the vast majority of PCSs to the aqueduct are found along this reach. Additional focus is also placed on section 5 because of the potential influence of the KRI. Greater detail is provided for these 2 sections because of their higher potential to affect SWP water quality.

8.1 CLIFTON COURT FOREBAY TO O'NEILL FOREBAY

8.1.1 WATER SUPPLY SYSTEM

8.1.1.1 Description of Aqueduct and SWP Facilities

This section of the California Aqueduct includes the reach from the intake into Clifton Court Forebay to the Harvey O. Banks Delta Pumping Plant at mile 3.04, to just before O'Neill Forebay at mile 66.8. The major facilities that make up this portion of the aqueduct include Clifton Court Forebay, the Banks Pumping Plant, Bethany Reservoir, and 2 concrete-lined canals. Key features of this aqueduct reach are presented in Figure 8-1.

Clifton Court Forebay is in the southwestern part of the Delta between Tracy and Byron and is bounded by Byron Tract on the northwest, Victoria Island on the north, Coney Island on the northeast, and the Byron-Bethany Highway on the south. The forebay stabilizes the water surface for the intake of the Banks Pumping Plant at a slightly higher level to reduce pumping costs and improve water quality in the aqueduct and through the southern portion of the Delta. Timed operation of the forebay intake gates bring Sacramento River water upstream through the San Joaquin River channel.

Figure 8-1 California Aqueduct: Clifton Court to O'Neill Forebay

Clifton Court Forebay has a surface area of 2,180 acres and a nominal storage capacity of 31,260 af, assuming a 14-foot average depth. Over the years, silt has settled in the forebay, reducing storage capacity. Present depths are estimated at 0.2 foot to 9 feet, except for a deep scour hole just inside the inlet structure. Water flows into Clifton Court from the northern and eastern portions of the Delta by way of Old River and the Victoria Canal into the intake structure at the southeast corner of the forebay. When flows in the San Joaquin River are low, water intake is timed for an outgoing high tide, so that water continues to flow upstream in the portion of Old River between Clifton Court and the central portion of the Delta. Water flows out of Clifton Court through the John E. Skinner Delta Fish Protective Facility to the Banks Pumping Plant via a 3-mile long intake channel.

The Banks Pumping Plant is the 1st of several on the aqueduct that transport water south along the western side of the San Joaquin Valley, parallel to the Coast Ranges. At the Banks Pumping Plant, water is lifted 244 feet into the California Aqueduct. From the Banks outlet, water travels 1.5 miles in a concrete-lined canal to Bethany Reservoir, which is a flow-through reservoir with a storage capacity of 5,070 af; a 6-mile long shoreline; and a surface area of about 180 acres. Bethany Reservoir's water surface elevation is controlled by radial gates at Check 1. The maximum water surface elevation is 245 feet above sea level. Beyond Check 1, water flows 61 miles through the concrete-lined canal, controlled by check structures every few miles until at Check 12 it flows into O'Neill Forebay.

Table 8-1 Description of Structures from Banks Pumping Plant to O'Neill Forebay

Type	Number
Drain inlets for canal operating road and/or canal right of way	485
Drain inlets for canal right of way and upslope range and cropland	23
Drain inlets for canal right of way and public roads or highways	3
Pump pads for portable storm water runoff pumps	1
Overchutes	26
Evacuation culverts	16
Submersible pumps for relieving canal seepage and/or groundwater pressure against the canal liner	9

Source: DWR memo from Dick Buchan to Don Kurosaka, 4 May 1992; Brown and Caldwell 1990

Aside from the main canal and its control gates and pumps, this section of the aqueduct contains a number of structures built to handle surface water runoff and groundwater inflows (Table 8-1).

Some local runoff from cropland or rangeland is conveyed into the aqueduct via the 23 drain inlets. However, most runoff is conveyed around the aqueduct in overchutes and evacuation culverts that intercept upslope runoff and convey it to the downslope, or eastern side of the aqueduct. There are 42 of these structures and 1 pump pad in this section of the aqueduct (Table 8-1). Groundwater can be pumped into the aqueduct via Department of Water Resources (DWR) sump pumps. These are automated groundwater pumps that relieve groundwater pressure on the upslope, or western side of the canal liner. Groundwater can also be pumped in at water service turnouts to supplement downstream supplies.

There are also numerous structures on the aqueduct unrelated to drainage. These include bridges, pipeline crossings, and fishing areas (Table 8-2).

Table 8-2 Nondrainage Structures from Banks Pumping Plant to O'Neill Forebay

Type	Number
Bridges	45
State	2
County	35
Farm or private	8
Pipeline overcrossings	76
Fishing areas	3

8.1.1.2 Description of Agencies Using SWP Water

There are 6 water service turnouts in the aqueduct from Clifton Court to O'Neill Forebay. These are predominately for agriculture services with possibly some domestic use. Five are pumped, and 1 flows naturally by gravity. Oak Flat Water District, the only SWP contractor in this section, draws the water for agricultural use with 4 turnouts from mile 42.46 to mile 46.18.

8.1.2 WATERSHED DESCRIPTION

No watershed runoff enters the 1st section of the California Aqueduct. The western side of the San Joaquin Valley through which this section flows is primarily composed of cropland and rangeland.

8.1.3 POTENTIAL CONTAMINANT SOURCES

8.1.3.1 Recreation

Recreational use of Clifton Court Forebay is limited to fishing and duck hunting. Fishing is done from the 8-mile shoreline, and duck hunting is done from the shoreline and from small nonmotorized skiffs. There is no boat ramp, and no restrooms are provided. Access to the levees around the forebay is limited to walk-in and boat-in, so the full length of the shoreline is not well used. Boats are not allowed to pass through the gates. With no power boats, gasoline spills and MTBE contamination do not originate in the forebay but can be imported from the Delta through the intake gates. With no restrooms, there is potential for fecal contamination of the forebay waters.

Recreational use is measured in units of "recreation days," which are defined as 1 user visiting the area during part of a 1-day period. No count has been made of recreation days at Clifton Court Forebay. A rough estimate would be fewer than the 1998 count of about 32,000 recreation days for nearby Bethany Reservoir, where boating is allowed. Therefore, a reasonable estimate would be about 20,000 to 30,000 recreation days per year at Clifton Court.

Body and nonbody contact recreation occur in Bethany Reservoir, which is operated by the California State Parks. Recreational activities include boating (power and sail), swimming, fishing, and picnicking. No camping is allowed. There are 4 chemical toilets provided for the general public. All of these activities can contribute pathogens and hydrocarbons. Visitor attendance is shown in Table 8-3.

Table 8-3 Visitor Attendance at Bethany Reservoir

Fiscal Year	Total Attendance	Boat Launching
1995/96	14,496	194
1996/97	11,007	259
1997/98	14,181	295
1998/99	13,950	292
1999/00	26,175	497

Source: California State Parks

The aqueduct is also accessible to the public for fishing through gated structures at 3 locations. These gates allow people to enter but exclude the entry of motor vehicles. Two of these locations are equipped with portable chemical toilets.

8.1.3.2 Wastewater Treatment/Facilities

Domestic wastewater collection, treatment, and effluent storage facilities serve the employees at the Banks Pumping Plant. These facilities were reported to be in good condition and should not pose any significant hazard to the water conveyance facilities (Brown and Caldwell 1990).

8.1.3.3 Urban Runoff

There are 485 toe drains that convey runoff into the aqueduct from canal operating roads, but they are not considered a major source of inflow. Most of the runoff from the drain inlets is conveyed around the aqueduct in overchutes or evacuation culverts. During wet periods, several hundred drain inlets convey canal shoulder runoff directly into the aqueduct. Most of these drains range in size from 4 to 12 inches in diameter. Three drains also allow storm water from nearby Interstate Highway 5 and State Highway 205 to enter the aqueduct. This inflow can contribute solids, metals, oils, and grease as well as any spilled materials.

8.1.3.4 Animal Populations

Livestock Grazing

There is no grazing on land south of Clifton Court, which drains into the forebay. Typically, crops such as alfalfa and corn are grown in this area. There is a possibility of cattle grazing after harvest to clean up the silage. Several drain inlets along the aqueduct accept rainfall runoff from adjacent rangeland. *Sanitary Survey 1990* estimated the size of watersheds contributing inputs to the aqueduct ranges from 100 to 200 acres. Floodwater from these lands as well as from cropland are conveyed into the aqueduct at 22 locations.

The Bethany Reservoir watershed is surrounded by about 500 to 600 acres of undeveloped land used primarily for cattle grazing. California Department of Health Services (DHS) has been concerned about cattle having direct access to the shoreline of Bethany Reservoir (Brown and Caldwell 1990). Cattle grazing in the watershed may contribute pathogens, organics, and nutrients into the water.

During a routine canal patrol in 1998, DWR field staff observed a corral next to the aqueduct near mile 52 that had been set up to hold cattle grazing on adjacent land. Although the corral was on the eastern side, it was on land that was higher than the aqueduct. A toe drain on the aqueduct was less than 10 feet from the corral and conveyed runoff from this land and the levee road. Field staff located the rancher and asked him to move the corral. The rancher complied, and the corral now poses little threat to water quality.

Waterfowl

Large numbers of ducks and geese use Clifton Court Forebay during migration season. Seagulls and cranes are present at all times in the forebay, feeding on shallow-water fish. Although counts are not available, there is potential for fecal contamination from waterfowl.

8.1.3.5 Algal Blooms

The warm, shallow, nutrient-rich water in the forebay provides optimal conditions for algae growth. High nutrient loads are caused by incoming Delta water and resident and transient waterfowl. The primary adverse effects on water quality associated with algal blooms are increased turbidity and taste and odor resulting from the production of 2 organic compounds, MIB and geosmin.

8.1.3.6 Agricultural Activities

Pumped agricultural drains on the south side of Clifton Court serve about 1,000 acres, making contamination by fertilizers and pesticides possible. However, no information is available on fertilizer or pesticide use. The herbicide Komeen is sprayed during the months of May and June in Clifton Court to control aquatic weeds.

Rainfall runoff from agricultural land is possible at 1 inlet draining the intensively farmed 100- to 200-acre parcel upstream of the aqueduct that was reported in *Sanitary Survey 1990*. There are 16 undercrossings of relatively large pipelines ranging from 36 to 93 inches in diameter. Fourteen of the pipelines convey storm drainage from undeveloped lands, lands grazed by cattle, and lands that are intensively farmed. Agriculture drainage in the watersheds of Bethany Reservoir may contribute pesticide residues from agricultural chemical or fertilizer or both.

Below mile 32.60, seasonal aerial spraying is more pronounced because of the intensive farming practices. The major threat to water quality is from overspray of the aqueduct. This has been observed by field staff on numerous occasions. At times, crop dusters have left a visible layer of a powdered substance, believed to be sulphur dust, on the surface of the aqueduct. Overall, agricultural activity is considered a minor threat to water quality.

8.1.3.7 Wind Erosion

With high winds common in the Clifton Court area, wind friction on the water surface of the 2-mile reach across the forebay can create high waves. These waves can range from 1 to 2 feet. Riprap protection on the surrounding levees minimizes wave erosion and the resulting turbidity, but shallow water areas are susceptible to wave action and can generate sediments that are pumped into the aqueduct. This is considered a moderate potential threat to water quality.

8.1.3.8 Accidents and Spills

There are 76 pipeline crossings in this section of the aqueduct (Brown and Caldwell 1990). The largest pipeline noted was 60 inches in diameter. Oil, storm drainage, irrigation water, and natural gas flow through these pipelines. Hazardous spills on Highway 152 would drain directly into O'Neill Forebay. Roadside drainage from Interstate Highway 5 and State Highway 205 could also allow hazardous material to drain into the aqueduct. *Sanitary Survey 1990* reported a few leaks in petroleum pipelines adjacent to the aqueduct. Since then, only 1 major incident has been documented regarding leakage from these pipelines.

On 9 August 1997, a small portion of aqueduct liner slumped into the water at mile 62.23 when the aqueduct was shut down for repairs upstream. On startup, oil was observed, and absorbent booms were deployed downstream. Monitoring for hydrocarbons began on a daily basis. Some remediation was attempted by excavating soil and treating groundwater. The oil leakage was attributed to residual oil from a 1984 pipeline break, which was discovered when hydrocarbons were detected in a sump pump at mile 62.39 (DWR 1999d). The residual oil found in 1984 was from a release of crude oil that was reportedly up to 1,000 barrels (50,000 gallons) and had migrated east and northwest.

Contamination associated with these incidents has continued to be a problem in this reach of the aqueduct. The Tosco/Pacific Environmental Group has been remediating and monitoring groundwater at this site. In September and October 1999, DWR Project Geology staff reviewed operation status reports. The review indicated that groundwater contamination on the west side of the aqueduct has continued to migrate eastward toward the SWP and that contamination is also now present on the east side of the aqueduct. Staff's conclusion was that the contamination posed a threat to water quality in the SWP (Glick pers. comm. 1999).

To date Tosco/Pacific Environmental has not fully characterized the extent of soil and groundwater contamination. Remediation activities include a groundwater monitoring, interception and extraction, and treatment system. DWR believes that these systems are insufficient to prevent the flow of contaminated water into the aqueduct and recommends that the full extent of the contamination be determined and a thorough site characterization be completed in order to conduct a public health risk assessment.

This is considered a significant threat to water quality.

8.1.3.9 Groundwater Discharges

Groundwater is pumped into the aqueduct at many locations to reduce the pressure of shallow groundwater on the aqueduct. The aquifer moving east from the Diablo Range must be kept below a certain level to prevent canal liners from being displaced. Groundwater pump-ins in this section have historically, been small relative to the other sections of the California aqueduct. However, pumping groundwater into the aqueduct may contribute sodium, chloride, sulfate, trace elements, and total dissolved solids (TDS).

Pumped-groundwater drains on the western side of Clifton Court discharge into Italian Slough and do not directly affect the forebay. Along the northern and eastern sides is a double levee system where pumps between the levees hold the groundwater level below the surface, protecting the back side of the levees from wave wash. Groundwater in this area tends to be high in salinity (Byron Hot Springs is only 2 miles to the west), but the total pumped flow is insignificant compared to the volume of Clifton Court.

Groundwater can also enter the aqueduct at water service turnouts. From 1990 to 1996, pump-ins from water service turnouts occurred throughout the entire length of the California Aqueduct. These pump-ins were done to assist State and federal water contractors during periods of entitlement deficiency caused by the 1987 to 1992 drought. Only 1 of these pumps is in the 1st section of the aqueduct and was only briefly active during the reporting period. The Oak Flat Water District had pump-ins in 1992 that exceeded DWR water quality limits for nitrate and selenium (DWR 1994). The small amount of pump-in from the Oak Flat Water District was immediately stopped when high constituent levels were identified. Overall, the pump-ins are considered a minor PCS for the aqueduct.

Gas, Oil, Geothermal Wells

Groundwater contamination was found in 1997 at mile 62.23 from an oil leakage attributed to the 1984 pipeline breaks. Contamination associated with these incidents has continued to be a problem in this part of the aqueduct and is discussed in Section 8.1.3.8.

8.1.3.10 Geologic Hazards

The south levee of Clifton Court Forebay lies parallel to the Vernalis geologic fault. The Vernalis fault runs northwest, southeast under or close to the forebay, following the Coast Ranges. Byron Hot Springs is 2 miles west of Clifton Court, and the local groundwater is relatively saline, similar to water in some of the nearby springs. There is no indication of increased salinity in Clifton Court because of these groundwater inputs.

8.1.4 WATER QUALITY SUMMARY

8.1.4.1 Watershed

There were no major water quality problems noted for section 1 of the California Aqueduct other than the oil spill downstream of mile 62. Drain inlets and overcrossings probably contribute some pollutants from urban runoff, but there were no data or reports on this. It is most likely a minor source.

The August 1997 spill at mile 62.23 resulted in an oil sheen downstream in the aqueduct observed for about a week following the incident. The oil leakage was attributed to residual from a pipeline break in 1984. DWR's Operations and Maintenance Division (O&M) staff began monitoring for hydrocarbons on a daily basis. Samples were collected immediately downstream at mile 62.26 and 62.44, and approximately 4 to 4.5 miles farther downstream just above O'Neill Forebay. A sheen, and thus the likelihood of hydrocarbons, was also observed in O'Neill Forebay during the incident and in the aqueduct several times since the incident.

Parameters analyzed included total petroleum hydrocarbons (TPH), benzene, toluene, ethylbenzene, and xylene. All but TPH were detected for 6 days at various locations. With the exception of a benzene detection of 2.2 µg/L, all other samples were less than the maximum contaminant levels (MCLs) for these compounds. The MCL for benzene is 1 µg/L.

The Tosco/Pacific Environmental Group has been monitoring groundwater in the site area since 1996. Its monitoring reports from 1998 and 1999 indicate significant groundwater contamination remaining in several wells adjacent to the aqueduct.

Table 8-4 includes a summary of data from 4 aqueduct sites downstream of the spill and from area wells monitored by Tosco/Pacific Environmental Group.

Table 8-4 Summary of Hydrocarbon Contamination Data Mile 62.23 Oil Spill

Site	Dates	# of Samples	# of Detects	Range of Hydrocarbon Concentrations (µg/L)				
				TPH	Benzene	Toluene	Ebenzene	Xylenes
Aqueduct (mile)	11 Aug 1997- 2 Oct 1997							
62.26[a]	-	21	5[b]	<50-220	<0.5-2.2	<0.5-0.59	<0.5-0.64	<0.5-5.7
62.44	-	22	2[b]	<50-5,400	<0.5	<0.5-1.3	<0.5-0.5	<0.5-2.2
66.32	-	23	3[b]	<50-110	<0.5-0.76	<0.5-0.89	<0.5-0.61	<0.5-2.1
66.77[c]	-	6	0					
Area Wells[d]	1998-1999	N/A	N/A	450-2,200	4-5.4	0.7	N/A	2.3-25

Sources: Aqueduct data, DWR O&M 1997a; well data, Glick pers. comm. 1999
[a] No hydrocarbons detected at upstream sample location mile 61.36
[b] Almost all detects occurred within 1 week after incident
[c] Includes 3 samples immediately above O'Neill Forebay
[d] Includes data in Tosco reports from 1-3 wells with detected contamination. Several well samples had floating product as much as 0.4 feet.
Ebenzene - Ethyl Benzene; N/A - not available

8.1.4.2 Water Supply System

The Banks Pumping Plant is the major water supply feature and primary monitoring point associated with section 1 of the California Aqueduct. Water quality data for Banks Pumping Plant are presented in Chapter 4, Sacramento/San Joaquin Delta, and Chapter 5, South Bay Aqueduct/Lake Del Valle.

8.1.5 SIGNIFICANCE OF POTENTIAL CONTAMINANT SOURCES

The largest known source of contaminants in the 1st section of the California Aqueduct is oil contaminated soil near mile 62.23 that entered the SWP as the result of a canal liner slump in 1997. After the oil sheen was detected, groundwater interceptor pumps were installed around the area to prevent further seepage. An absorbent oil boom was placed in the aqueduct and continues to be maintained at the time of this report. These actions, along with the fact that hydrocarbons are very volatile and there is a lengthy travel time to most downstream users, indicate that this contamination source is of low to moderate significance.

The only other major source of potential contamination in section 1 of the aqueduct is from rainfall runoff. *Sanitary Survey 1990* identified several watershed areas that drain to the aqueduct as either cropland or rangeland. The watershed for this section of the aqueduct covers from 100 to 200 acres, relatively small when compared to similar land that drains into the SLC (Section 8.3, Outlet of O'Neill Forebay to Check 21) and can exceed 500 square miles. Although runoff to section 1 of the aqueduct probably contains pathogens, pesticides, nutrients, and organic carbon, the relative size reduces its significance to a minor PCS to the SWP.

8.1.6 WATERSHED MANAGEMENT PRACTICES

There are no known watershed management activities in section 1 of the California Aqueduct that impact water quality. However, because of routine canal patrols and emergency plans in place as discussed in Chapter 11, State Water Project Emergency Action Plan, the potential discharge of pathogens and other contaminants was reduced because of action taken by DWR staff.

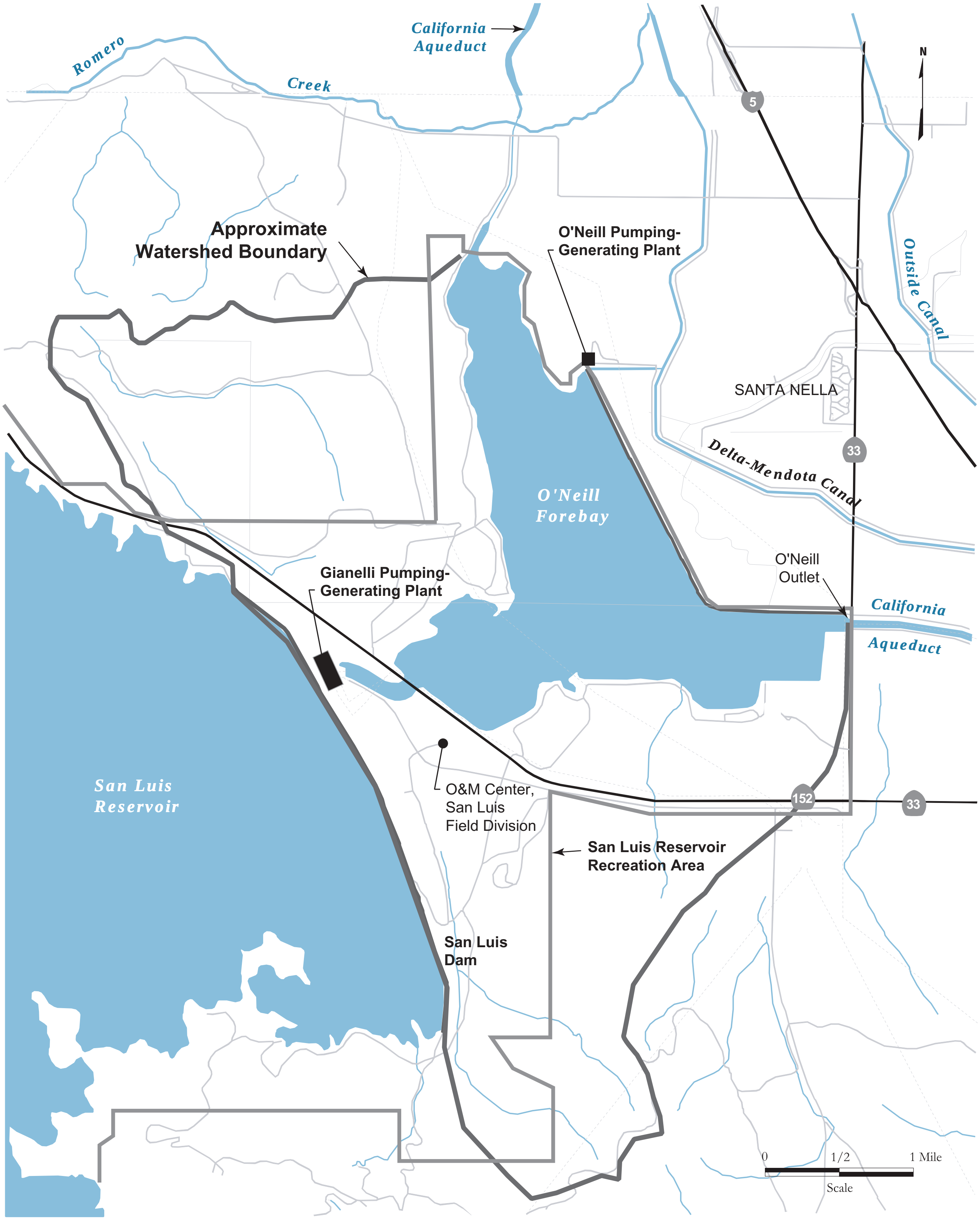
8.2 THE O'NEILL FOREBAY

8.2.1 WATER SUPPLY SYSTEM

8.2.1.1 Description of Aqueduct and SWP Facilities

O'Neill Forebay, part of the San Luis Field Division's Joint-Use Facilities, is operated to deliver water to State and federal water contractors (see detailed description of joint-use operations for the SLC in Section 8.3) and to San Luis Reservoir. O'Neill Forebay has a gross storage capacity of 56,436 af, a maximum depth of 40 feet, a surface area of 2,700 acres, and 12 miles of shoreline (Figure 8-2). The forebay has a glory hole spillway that leads to a cut-and-cover conduit. Spillway water is routed under the dam to a stilling basin and then to the approach channel to O'Neill Pumping-Generating Plant. The spillway was designed in case an outage prevented floodwater releases via the pumping-generating plant.

Figure 8-2 Watershed of O'Neill Forebay



Because the drawdown of San Luis Reservoir sometimes affects its recreation potential, a proportionately greater investment was made in recreation amenities at O'Neill Forebay. Operated by the California State Parks, the forebay offers camping, picnicking, sailing and power-boating, water-skiing, windsurfing, fishing, swimming, and bicycling. There are 2 boat launches, 45 pit toilets, and 7 Comfort Stations (equipped with toilets and sinks) around the shoreline.

Delta exports enter the forebay from the aqueduct via Check 12 and from the DMC via O'Neill Pumping-Generating Plant (Figure 8-2). From the forebay, water either flows down the aqueduct though O'Neill Outlet or is pumped into the San Luis Reservoir for release later in the year when demand is greater than Delta diversions. Releases can supply water to both the California Aqueduct and the DMC. From 1996 to 1999, 2.5 million to 4 million af were sent down the aqueduct while 1 million to 2 million af were pumped into San Luis Reservoir (Figure 8-3). A small amount (0.03 million to 0.14 million af) was released back into the DMC, mostly during the summer. Joint-use facilities minimize energy costs for pumping and delivering water on demand (DWR 1974).

Increased outflow from O'Neill Forebay to the California Aqueduct generally coincides with San Luis Reservoir releases during spring and summer. Water from the forebay is pumped into San Luis Reservoir largely during fall and winter when SWP demands are low and excess water can be stored. The combined operation of these facilities determines the quality of water in the forebay and what is ultimately sent down the aqueduct.

8.2.1.2 Description of Agencies Using SWP Water

There are no water service turnouts in O'Neill Forebay.

8.2.2 WATERSHED DESCRIPTION

Most of the watershed draining to O'Neill Forebay is native grassland (Figure 8-2). The watershed south of the forebay is gradually sloping rangeland with no discernable drainage channel. It is well vegetated and accepts runoff from a wide area beginning near Basalt Campground next to B.F. Sisk San Luis Dam. Most of the land north of the forebay is open grassland, designated as a wildlife area. The DFG owns and maintains the land outside the park boundary. Although no runoff data exist for this area, small eroded gullies were observed in the larger drainage pathways leading to the forebay. Because there is no distinct channel and no signs of erosion, flows of significance are unlikely. Regardless, any runoff draining this area would sheet flow across well-vegetated swales and natural depressions as it approaches the forebay.

Figure 8-3 O'Neill Forebay Inflow and Outflow, 1996 to 1999

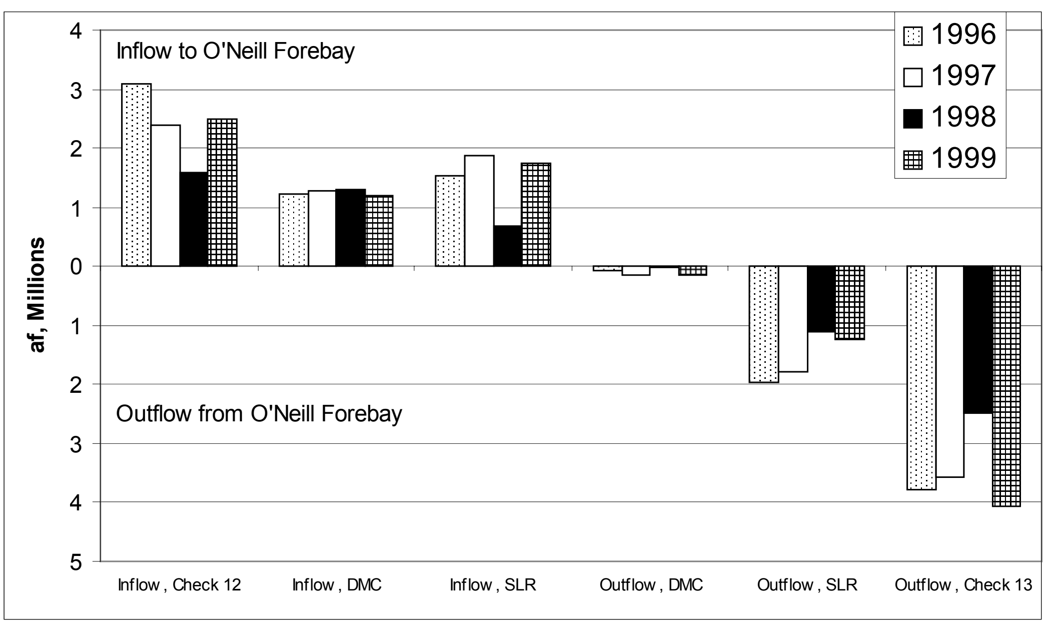
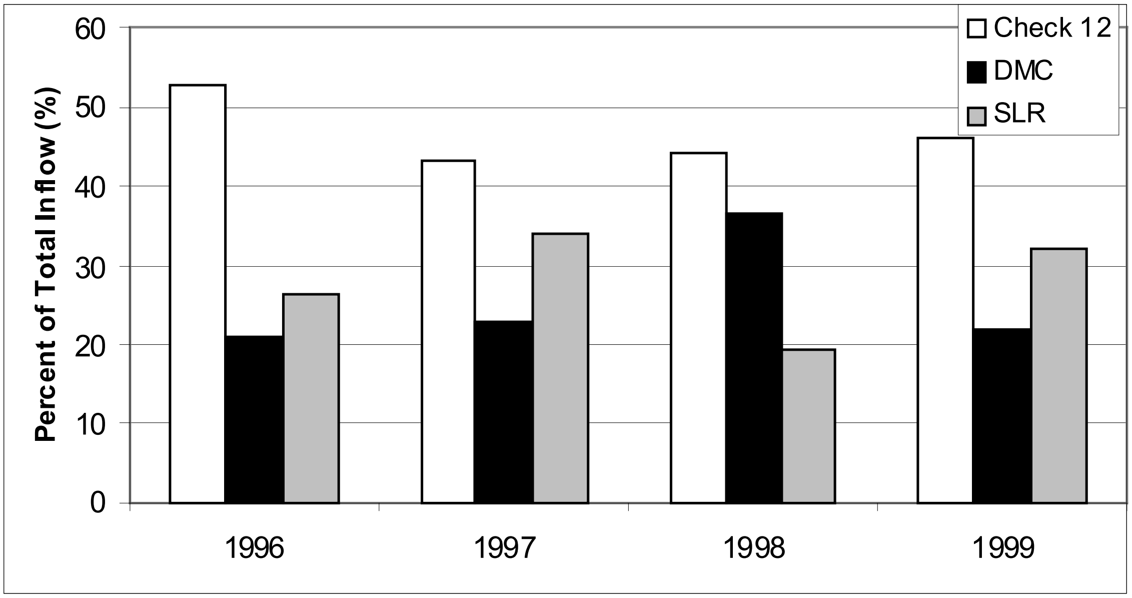


Figure 8-4 Percent of Total O'Neill Forebay Inflow from the California Aqueduct at Check 12, Delta Mendota Canal, and San Luis Reservoir, 1996 to 1999



Impervious land in the watershed is limited to roads, a few buildings, and DWR's San Luis Field Division operational facilities. Highway 33 runs along the east side of the forebay and crosses it just below the San Luis Reservoir (Figure 8-2).

8.2.3 POTENTIAL CONTAMINANT SOURCES

There are a number of PCSs to O'Neill Forebay including swimming, cattle grazing, and boating. However, inflows from the California Aqueduct, San Luis Reservoir, and DMC are arguably the largest influence on water quality in the forebay. The first 2 sources are discussed elsewhere in this report (Section 8.1, Clifton Court Forebay to O'Neill Forebay, and Chapter 6, respectively). Although not considered a PCS, the DMC is discussed here because it is a major source of inflow to the SWP, there are a number of PCSs on the DMC, and its inflows are not discussed anywhere else in this report. A discussion of the DMC is followed by individual PCSs in the forebay's watershed.

8.2.3.1 The Delta-Mendota Canal

Completed in 1951, the DMC carries water from the southern Delta along the western side of the San Joaquin Valley for irrigation supply, for use in the San Luis Complex, and to replace San Joaquin River water stored at Friant Dam and used in the Friant-Kern and Madera systems. The canal is about 117 miles long and terminates at Mendota Pool. O'Neill Pumping-Generating Plant can pump DMC water into O'Neill Forebay at mile 69.25 on the DMC.

From 1996 to 1999 the DMC accounted for 21% to 37% of the inflow to O'Neill Forebay or a little more than one-fourth of the total inflow during the 4-year period (Figure 8-4).

The aqueduct at Check 12 accounted for the majority of inflow to O'Neill Forebay with 43% to 53% followed by San Luis Reservoir releases with 19% to 34%.

A number of studies have concluded that DMC water has a different composition than State exports largely because of San Joaquin River influence. *Sanitary Survey 1990* stated that SWP diversions are composed of 70% Sacramento River water and 30% San Joaquin River water (Brown and Caldwell 1990). During wet years, a greater proportion comes from the San Joaquin. During critically dry years, the DMC diverts San Joaquin water almost exclusively while the aqueduct receives only Sacramento water. These descriptions had been obtained from discussions with DWR modeling staff. Various models can provide flow, stage height, and salinity estimates for a variety of stations around the Delta. Models have been used extensively to predict the effects of proposed Delta modifications on export salinity.

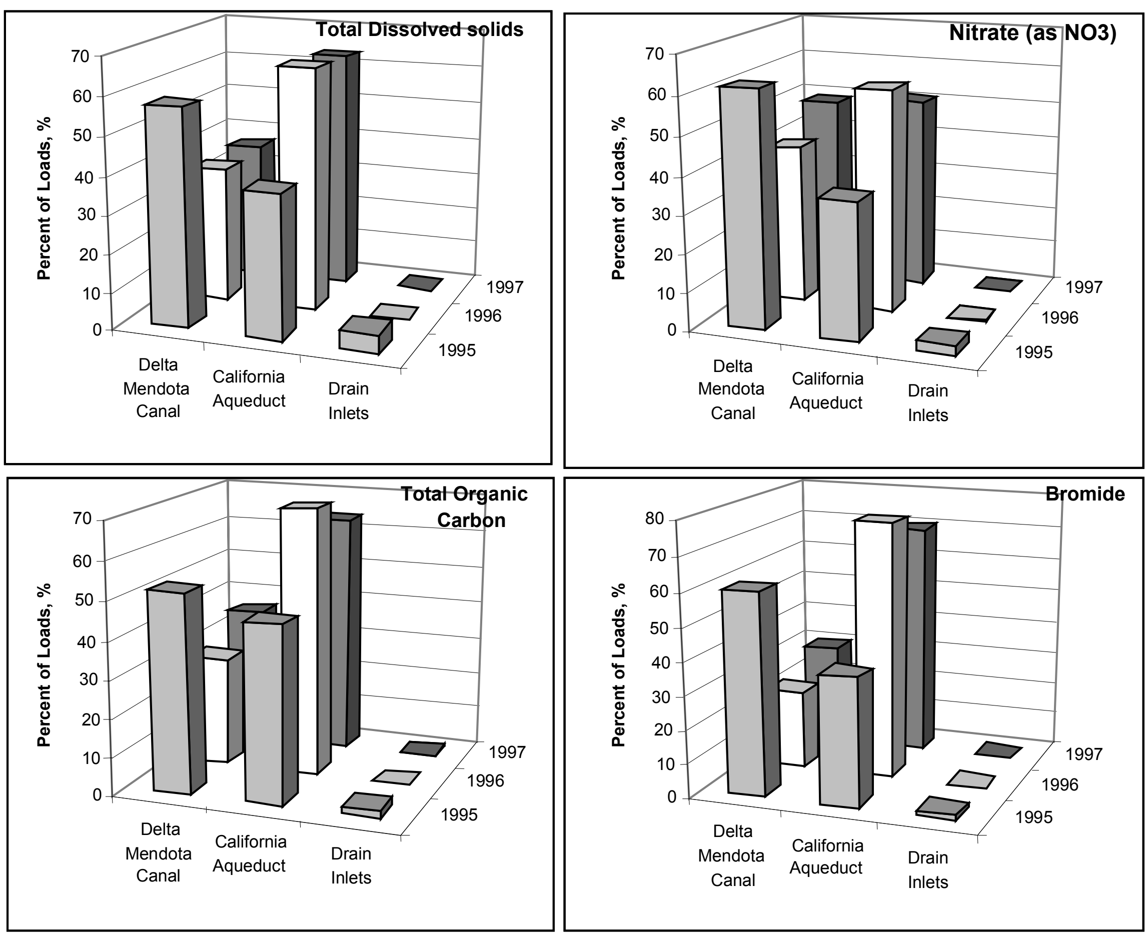
One particular modeling run estimated export composition for a critical water year (Orlob 1991). Salt contributions from the Sacramento and San

Joaquin rivers, tidal boundary (seawater intrusion), and in-Delta agriculture were estimated without south Delta barriers. The composition of federal exports in July of a critical year was 12% San Joaquin and 60% Sacramento. The rest was made up by seawater intrusion (17%) and in-Delta agriculture (11%). For State exports during the same month and water year type, the composition was 1% San Joaquin and 68% Sacramento followed by seawater intrusion and in-Delta Agriculture. Export composition was also estimated for May and Sepember of a critical year. For May, federal and State exports were 34/2% San Joaquin and 52/73% Sacramento. For September, federal and State exports were 30/1% San Joaquin and 52/73% Sacramento. Seawater intrusion and in-Delta agriculture made up the rest. These modeling runs confirm the preceding general description that State exports contain very little San Joaquin water (1% to 2%) in a critical water year.

The difference in river proportion between State and federal exports should also result in differences in their water quality. Based on this information, DMC inflow to O'Neill Forebay is not expected to have the same water quality as that from the aqueduct. No study has definitively quantified the difference in water quality between these 2 sources. Regardless of any possible concentration differences, the relative influence of these sources on the overall contribution of constituents to O'Neill Forebay can be assessed by loads, that is, the combination of concentration and inflow volume.

An unpublished loading study by O&M shows that salt and carbon loads from the DMC to O'Neill Forebay can surpass those from the California Aqueduct. Annual loads to O'Neill Forebay were calculated for TDS, nitrate, total organic carbon (TOC), and bromide for the years 1995 through 1997. Floodwater inflows were included for comparison. In all 3 years, floodwater inflows were minor in proportion to loads from the DMC and California Aqueduct (Figure 8-5).

Figure 8-5 Relative Loads of TDS, Nitrate, Bromide, and TOC to O'Neill Forebay and the San Luis Canal, 1995 to 1997



The DMC contributed 23% to 36% of the TDS, TOC, and bromide loads during 1996 and 1997 and from 52% to 60% of these loads during 1995 (Figure 8-5). The California Aqueduct accounted for 63% to 77% of the TDS, TOC, and bromide loads during 1996 to 1997 and from 38% to 46% of the 1995 loads. Therefore, DMC loads to O'Neill Forebay were higher than that from the aqueduct during 1995. That year the DMC contributed 47% of the total forebay inflow followed by the aqueduct with 33%. Therefore, the DMC is a significant source of a variety of water quality constituents, and in 1995, it was the largest source.

Similar to the aqueduct, there are several structures that cross over the DMC such as gas and power lines, bridges, turnouts, and safety float lines (Table 8-5). It should be noted that these structures are between the start of the intake canal, north of Tracy Pumping Plant, to mile 69.25 where the DMC reaches O'Neill Forebay. There are 76 bridges in this section of DMC including county roads, 2 Interstate 5 crossings, and timber structures used by farmers. Numerous pipelines were identified as petroleum or irrigation; there were also a number of unidentified pipelines. The significance of these as PCSs is similar to those on the aqueduct as discussed in *Sanitary Survey 1990*. However, unlike most of the aqueduct, the DMC was built with numerous drain inlets that accept drainage from adjacent upstream land.

Table 8-5 Structures that Cross Over the DMC, Mile Zero to 69.25

Structure	Number
Road Bridges	76
Railroad Bridges	2
Oil Pipelines	11
Irrigation Pipelines	12
Gasoline Pipelines	2
Small Drain inlets (6 to 30 inch)	187
Large Drain Inlets (>30 inch to 5.0 x 2.6 ft)	77
"Weed Oil Tank"	1

Source: USBR 1996; DMC Structures List.

There are 187 small drain inlets within the first 69 miles of the DMC. Some of these were identified as "shoulder drain inlets" and are probably similar to toe drains on the aqueduct handling runoff from adjacent operating roads. The larger drain inlets handle an unknown amount of runoff from the west side of the DMC. The land upstream from the DMC is mostly farmland, similar to what is present west of the SLC—row crops and orchards. Drainage from these lands is expected to be greatest during rainfall runoff events. Runoff from over-irrigation of adjacent lands is also possible during the summer. Large inflows from major watersheds are routed either over or under the DMC in structures similar to those on the aqueduct. Based on this information, the DMC is considered a moderate threat to water quality.

8.2.3.2 Recreation

Because the drawdown of San Luis Reservoir sometimes affects its recreation potential, a proportionately greater investment was made toward recreation amenities at O'Neill Forebay. Operated by the California State Parks, they include camping, picnicking, sailing and power-boating, water-skiing, windsurfing, fishing, swimming, and bicycling. Coliform bacteria data are collected at the swimming beaches and discussed under 8.2.4, Water Quality Summary.

The north side of the forebay is equipped with 2 designated swimming beaches (Figure 8-6). The northern and southern swimming beaches have 6 Comfort Stations with flush toilets and sinks, 2 shower facilities, and a fish-cleaning trough. All are equipped with running water. Wastewater flows to an underground holding vault, then it is pumped into 2 ponds, each 60 feet by 80 feet, for percolation and evaporation. The ponds are less than a mile from the shoreline. The wastewater vault has an alarm system for overflow prevention. The vault can be manually evacuated if the primary pump system goes down. There have been no reports of wastewater spills or leaks.

Figure 8-6 Recreation and Sanitary Facilities in the O'Neill Forebay Watershed

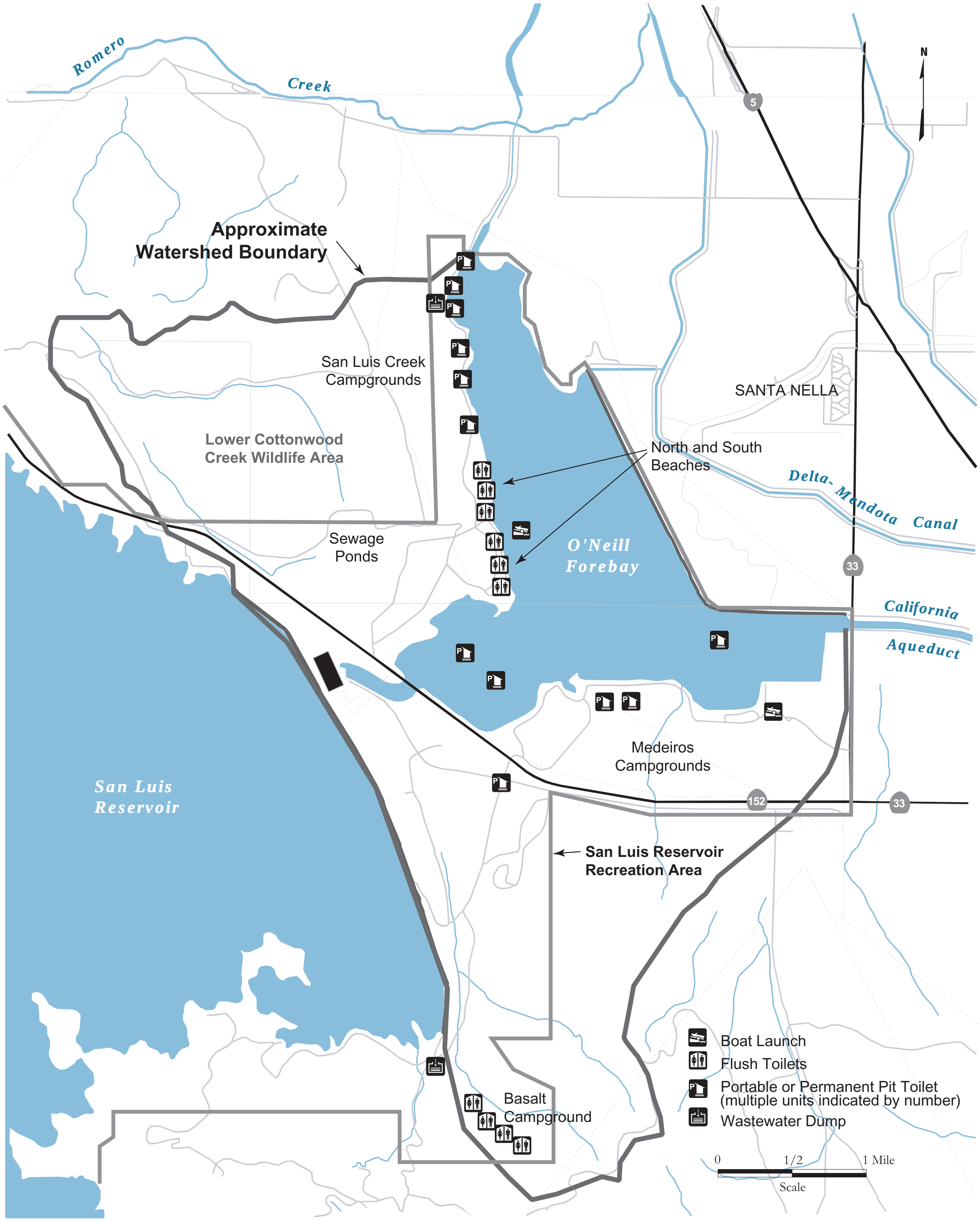


Table 8-6 Visitor Attendance and Use of the San Luis Reservoir Recreation Area, 1995 to 1999

Fiscal Year	Free Day Use	Paid Day Use	Camping Attendance	Total Attendance	Boat Launching
1995/96	80,000	389,000	57,000	526,000	18,000
1996/97	72,000	404,000	49,000	525,000	14,000
1997/98	46,000	289,000	35,000	370,000	11,000
1998/99	54,000	390,000	29,000	473,000	11,000

Source: California State Parks

The north shore campgrounds are equipped with running water and electricity. Nearby is a motor home dump station. Waste from this dump station is dissipated via underground leach lines. Concentrated near the north shore swimming beaches are more than 100 picnic tables (some with barbecue pits). There are also permanent and portable pit toilets that are pumped out when needed.

The forebay's southern shoreline is available for day use or camping. There are about 30 pit toilets (most of them portable) and a limited number of picnic tables on the south shore. Camping is allowed anywhere between the road and shoreline.

Within the forebay's watershed is the Basalt Campground. There are a number of Comfort Stations with flush toilets, sinks, and 1 dump station. Wastewater is conveyed to an underground vault and pumped south, over a hill, and into another watershed to evaporation/percolation ponds. The system is similar to that described above for the swimming beaches.

Visitor attendance records are not kept for O'Neill Forebay alone, but for the entire San Luis Reservoir Recreation Area (San Luis Reservoir, O'Neill Forebay, and Los Banos Reservoir). These are shown in Table 8-6.

Although these numbers are combined from all 3 reservoirs, a study published in 1989 provided use numbers for each water body (DWR 1989). From 1973 to 1987, O'Neill Forebay made up 38% to 66% of all visitors attending the entire recreation area with an average of 50%. Therefore, to get a rough estimate of the forebay's specific use numbers, halve the attendance numbers in Table 8-6. San Luis Reservoir provided about 29% to 48% of the total visitor use (average = 42%).

In 2000, the California State Parks lowered all use fees, possibly affecting future attendance numbers. North shore campground fees were reduced from $15/vehicle/night to $12; south shore camping fees, from $10/vehicle/night to $7; day use fees, from $5/vehicle to $2; and boat launching fees, from $5 to free. The lower costs may result in higher use numbers in the future.

8.2.3.3 Urban Runoff

There are no urban areas in the upstream watershed. Impervious land in the watershed is limited to roads, a few buildings, and the operational facilities of DWR, California State Parks, and California Department of Forestry and Fire Protection.

8.2.3.4 Agricultural Activities

There are no agricultural activities within the watershed of O'Neill Forebay.

8.2.3.5 Animal Populations

Livestock Grazing

Cattle grazing is the primary use of the forebay's southern watershed (within the park boundaries north of Highway 152). The California State Parks leases the land to a rancher for grazing between November and May. The entire grazing area is sectioned off into individual paddocks. Cattle are moved between these pens on a weekly basis to prevent overgrazing. An electric fence separates cattle from the forebay's shoreline. *Sanitary Survey 1990* stated that about 1,000 head of sheep also use the forebay's watershed for grazing about 6 months of the year (Brown and Caldwell 1990).

Wildlife

On the north shore of the forebay, the watershed outside of the park boundary is a wildlife area owned by the DFG. Mostly devoid of trees and brush, the most numerous mammals would be limited to rabbits and rodents. Trees and brush are abundant along the forebay's shoreline, providing cover for a small herd of deer. Other mammals include raccoons, opossums, skunks, foxes, coyotes, and feral cats.

8.2.3.6 Accidents/Spills

Transportation Corridors

State Highways 33 and 152 cross portions of O'Neill Forebay. Highway 133 is on the east side of the forebay and crosses it just below the San Luis Reservoir. There were no reported vehicle incidents during 1996 to 1999. The significance of transportation corridors as a PCS was addressed in *Sanitary Survey 1990*.

8.2.3.7 Fires

In 2000 a fire swept through the wildlife area on the north end of the forebay. Although there was no sign of heavy erosion, some of the larger drainage channels showed signs of a small amount of erosion. This is considered a minor threat to water quality.

8.2.4 WATER QUALITY SUMMARY

Water quality in the DMC at its connection with O'Neill Forebay is discussed below. Routine water quality samples are not collected in O'Neill Forebay. The closest water quality station is the forebay's outlet, and its data are discussed in the SLC section, Section 8.3. Routine coliform sampling in O'Neill Forebay was initiated in 1996 and is presented below after the DMC water quality analysis.

8.2.4.1 The Delta-Mendota Canal

DWR collects water quality samples in the DMC on a monthly basis just upstream the connection with O'Neill Forebay. All data were below primary and secondary MCLs.

TOC ranged from 2.3 to 6.5 mg/L (Table 8-7). The high concentration was detected in January 1998 when the DMC dominated inflows to O'Neill Forebay (Figure 8-7). Inflows from the aqueduct were limited from 14 January to 27 February of that year because of a shutdown at Banks Pumping Plant. Inflow down the aqueduct was mostly from the DMC and San Luis Reservoir releases. This was reflected in the water quality at O'Neill Outlet higher than normal TOC during January and February 1998 (DWR 2000).

Table 8-7 Delta Mendota Canal, Jan 1996 to Dec 1999[a]

Parameter (mg/L)	Mean	Median	Low	High	Percentile 10 – 90%	Detection Limit	# of Detects/ Samples
Minerals							
Calcium	18.9	18.0	8.5	34.0	11.8 – 26.4	1.0	45/45
Chloride	47	39	13	122	19 – 77	1	49/49
Suspended Solids	60	61	22	98	– [b]	1	3/3
Total Dissolved Solids	216	189	77	435	119 – 322	1	49/49
Hardness (as $CaCO_3$)	89	85	36	175	54 – 121	1	49/49
Alkalinity (as $CaCO_3$)	66	66	32	111	46 – 85	1	49/49
Conductivity	381	358	145	761	206 – 564	1	49/49
Magnesium	10.0	10.0	3.5	20.0	5.8 – 14.2	1.0	49/49
Sulfate	40	38	14	94	18 – 66	1	49/49
Turbidity (NTU)	20	16	3	68	16 – 24	1	40/40
Minor Elements							
Aluminum	0.02	0.01	<0.01	0.04	0.01 – 0.03	0.01	4/48
Arsenic	0.002	0.002	<0.001	0.003	0.001 – 0.002	0.001	45/48
Barium	0.05	0.05	<0.05	0.06	0.05 – 0.06	0.05	4/48
Boron	0.2	0.2	<0.1	0.4	0.1 – 0.3	0.1	43/49
Chromium	0.006	0.006	<0.005	0.006	–	0.005	3/48
Copper	0.002	0.002	<0.001	0.003	0.002 – 0.003	0.001	27/48
Iron	0.021	0.016	<0.005	0.076	0.006 – 0.039	0.005	28/48
Manganese	0.022	0.012	<0.005	0.081	0.007 – 0.052	0.005	15/48
Selenium	0.001	0.001	<0.001	0.001	0.001 – 0.001	0.001	10/47
Zinc	0.016	–	<0.016	0.016	–	0.005	1/48
Nutrients							
Total Kjeldahl Nitrogen(as N)	N/A [c]	N/A	N/A	N/A	N/A	0.1	N/A
Nitrate (as NO_3^-)	3.9	3.5	1.7	8.3	2.1 – 6.0	0.1	48/48
Ammonia (dissolved)	N/A	N/A	N/A	N/A	N/A	0.01	N/A
Nitrate+Nitrite (as N)	N/A	N/A	N/A	N/A	N/A	0.01	N/A
Total Phosphorus	N/A	N/A	N/A	N/A	N/A	0.01	N/A
Orthophosphate	N/A	N/A	N/A	N/A	N/A	0.01	N/A
Misc.							
Total carbon	3.52	3.20	2.3	6.5	2.58 – 4.88	0.1	45/45
Bromide	0.15	0.12	0.04	0.42	0.05 – 0.25	0.01	49/49
pH	7.5	7.4	6.9	8.8	7.0 – 8.0	0.1	49/49
UVA (cm^{-1})	0.077	–	0.072	0.081	–	0.001	2/2

[a] Data retrieved from DWR Division of Opersations and Maintenance's database, and were from 16 Jan 1996 to 15 Dec 1999.
[b] Computation of this statistic not needed due to a small sample size.
[c] Data not available.

Figure 8-7 Water Quality Summary for DMC, 1996 to 1999

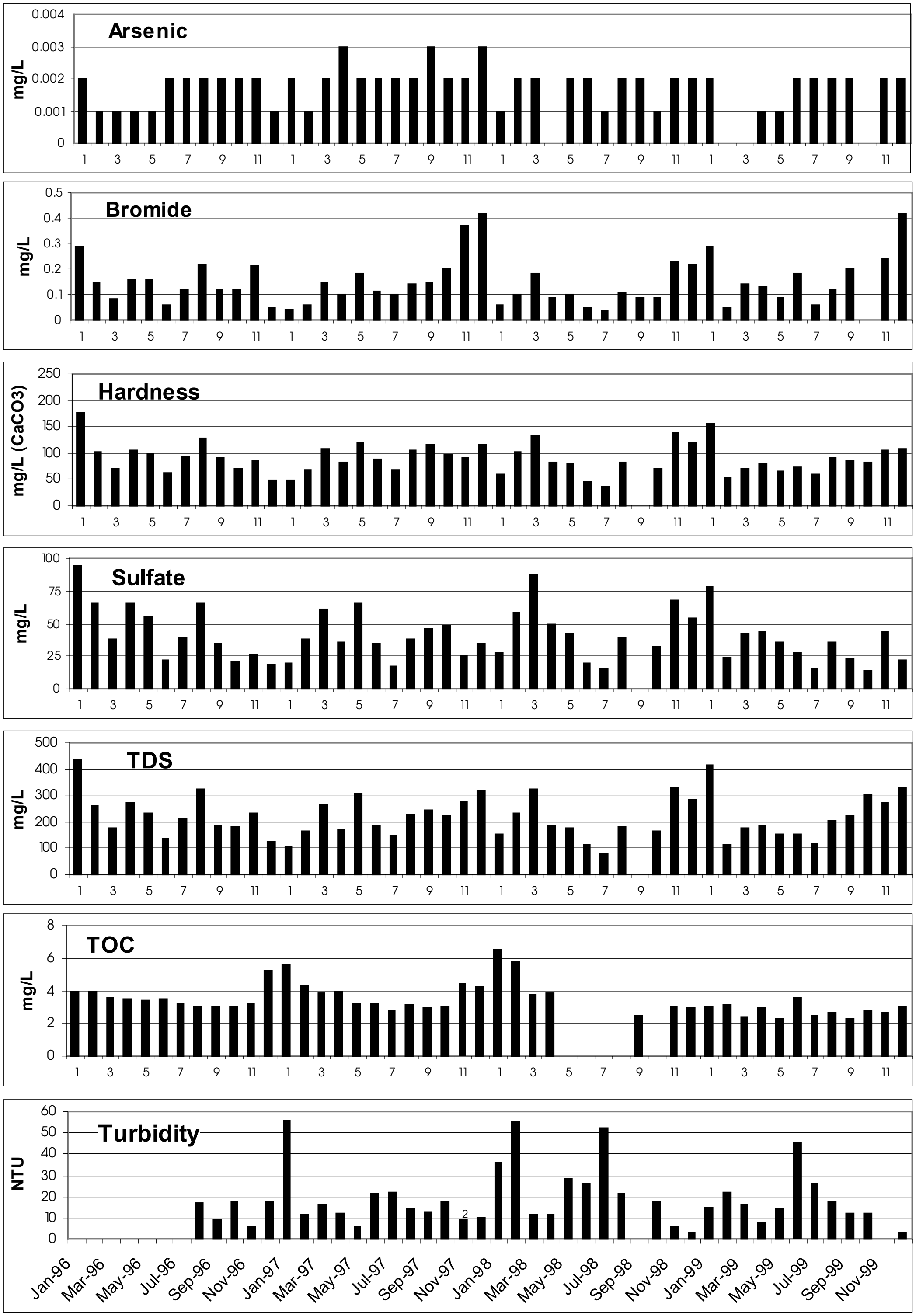
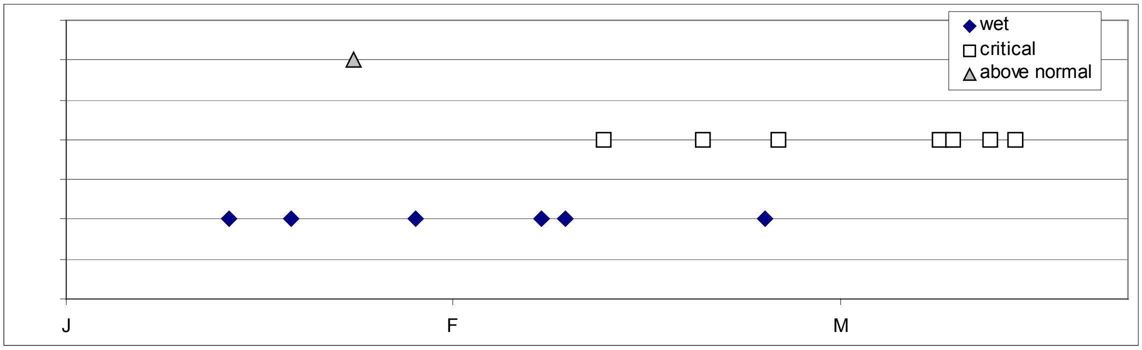


Figure 8-8 Onset of the 1st Peak Outflow from Mud and Salt Sloughs from Jan to Mar, 1985 to 1999 J=January, F=February, M=March



Bromide in the DMC ranged from 0.04 to 0.42 mg/L during 1996 to 1999 and was highest during the last few months of 1997 and 1999 (Figure 8-7). These trends were not unlike those in the aqueduct at Banks Pumping Plant. On the other hand, TDS in the DMC ranged from 77 to 435 mg/L and was sometimes more than 100 mg/L higher than levels measured at Banks Pumping Plant during the same month.

TDS exceeded 400 mg/L in January of 1996 and 1999 (Figure 8-7). These levels were much higher than those in the aqueduct at Banks Pumping Plant during the same months (160 and 270 mg/L, respectively). The higher TDS levels in DMC exports may relate to the effect of the San Joaquin River. As previously discussed, DMC exports may contain a greater proportion of San Joaquin River water than SWP exports. Although winter flows would typically have lower TDS because of rainfall runoff, winter in the San Joaquin Valley also coincides with the pre-irrigation season.

Each winter, pre-irrigation of west-side San Joaquin Valley farmland may be necessary, in part, to remove salts and prepare for spring planting (DWR 1974a). Water is applied to farmland prior to planting to remove salts accumulated in the soil during the previous growing season. The salt-laden water is conveyed to Salt and Mud sloughs and, eventually, the San Joaquin River via underground tile drains. Pre-irrigation occurs during winter so that the salty discharges can be diluted by the higher San Joaquin River flows (DWR 1960). This method of dilution remains 1 of the recommended strategies for meeting downstream water quality objectives year-round (SWRCB 1995). The onset of winter drainage varies with water year. During wet years, peak outflow from pre-irrigation occurs earlier in the season. Figure 8-8 shows the 1st peak outflow from Mud and Salt sloughs occurred largely during January or February of a wet year. During critical water years, peak outflow occurred later in the season, during February and March. There was 1 above-normal year during the period of record (1985 to 1999), and its 1st peak outflow occurred in late January. Exports could be influenced by this drainage earlier in the season during wet years than drier years. Arsenic in the DMC rarely exceeded 0.002 mg/L, and no seasonal trends were apparent.

Table 8-8 Total and Fecal Coliforms in O'Neill Forebay, 1996-1998

Year	Date	Station	Total Coliform[a]	Escherichia Coliform[b]
1996	2 Apr	North Beach	Positive	Positive
		South Beach	Positive	Positive
	16 Apr	North Beach	Positive	Positive
		South Beach	Positive	Positive
	22 May	North Beach	Positive	Positive
		South Beach	Positive	Negative
	4 Jun	North Beach	Positive	Positive
		South Beach	Positive	Positive
	18 Jun	North Beach	Positive	Positive
		South Beach	Positive	Negative
	9 Jul	North Beach	Positive	Positive
		South Beach	Positive	Negative
	23 Jul	North Beach	Positive	Positive
		South Beach	Positive	Negative
	14 Aug	North Beach	Positive	Positive
		South Beach	Positive	Negative
	27 Aug	North Beach	Positive	Positive
		South Beach	Positive	Negative
	10 Sep	North Beach	Positive	Negative
		South Beach	Positive	Positive
	24 Sep	North Beach	Positive	Negative
		South Beach	Positive	Negative
1997	24 Apr	North Beach	Positive	Positive
		South Beach	Positive	Positive
	28 May	North Beach	Positive	Positive
		South Beach	Positive	Negative
	11 Jun	North Beach	Positive	Positive
		South Beach	Positive	Positive
	1 Jul	North Beach	Positive	Negative
		South Beach	Positive	Negative
	22 Jul	North Beach	Positive	Negative
		South Beach	Positive	Negative
	19 Aug	North Beach	Positive	Negative
		South Beach	Positive	Negative
1998	27 Apr	North Beach	Positive	Positive

[a] Colilert® [b] Ultraviolet Light

8.2.4.2 O'Neill Forebay

From 1996 to 1998, coliform samples were routinely collected from the north and south swimming beaches in O'Neill Forebay. Coliform and *E. coli* were only recorded as present or absent; no quantifications were made. Field staff initiated the study to obtain background data on the effects of swimming.

Total coliforms were present in all samples (Table 8-8). Fecal coliform (or *E. coli*) was present in 13 of 17 samples collected from the north beach and in 6 of 17 samples from the south beach. The samples were collected during the workweek whenever it was convenient for field staff. High-use periods during the weekend and holidays were not monitored. Field staff recalled that most samples were collected when there was little or no swimming activity. This data would then represent coliform levels outside the periods of high use

8.2.5 SIGNIFICANCE OF POTENTIAL CONTAMINANT SOURCES

Of all the PCSs listed in Section 8.2.3, none would likely be large enough to overshadow the effects of State and federal inflows. Inflows from the DMC, California Aqueduct, and San Luis Reservoir largely control water quality in O'Neill Forebay.

One of the primary sources of potential contamination is boating. Boating is 1 of the main forms of recreation on the forebay and is a source of hydrocarbons and MTBE. However, samples collected at the outlet from 1996 to 1999 contained no volatile organics and, on 1 occasion, only 0.5 mg/L of MTBE. Organic samples were collected at the forebay's outlet in March, June, and September of each year from 1996 to 1999. It is possible that the large inflow volumes to the forebay quickly dilute any MTBE released by boating activity.

Animal populations may also contribute nutrients and pathogens and are considered a moderate threat to water quality. Although runoff from adjacent rangeland could enter the forebay during rainfall events, the amount is minimal because of the lack of any major drainage channel. Further, the rangeland is nearly flat, and runoff would sheet flow across well-vegetated land that has many depressions and swales. These features would provide a filtering effect that would tend to reduce the off-site movement of particulates and pathogens.

The park's wastewater facilities have adequate capacity to treat the waste load from visitors. They are also equipped with alarms and backup pumps in case the primary pumps break down. The sewage treatment ponds are distant from the forebay and do not pose a threat.

The 45 portable and permanent pit toilets surrounding the forebay pose a potential source of fecal contamination, although if any toilet is tipped over, the waste material would be contained on land. They are placed along the shoreline at close intervals, making them easily accessible. A contract firm routinely checks and empties them as needed. The toilets may be preventing contamination from human activities.

8.2.6 WATERSHED MANAGEMENT PRACTICES

Commingling of DMC and SWP waters in O'Neill Forebay has a large effect on water quality in the California Aqueduct. Joint-use facilities are operated to minimize energy costs for pumping and to deliver water on demand (DWR 1974), although Metropolitan Water District of Southern California (MWDSC) has recently requested that O&M use San Luis Reservoir releases to dilute high levels of Delta-imported TOC in the aqueduct.

8.3 OUTLET OF O'NEILL FOREBAY TO CHECK 21 (KETTLEMAN CITY): SAN LUIS CANAL

8.3.1 WATER SUPPLY SYSTEM

The San Luis Canal (SLC) is the part of the California Aqueduct that extends from O'Neill Forebay outlet at mile 70.89 (Check 13) to the end of San Luis Field Division at mile 172.40 (Check 21), a distance of about 101 miles (Figure 8-9). The SLC delivers water to both municipal and agricultural contractors. The United States Bureau of Reclamation (USBR) designed, funded, and constructed the SLC to provide water for agriculture, not to protect drinking water. This is significant because the agency did not extensively incorporate drainage conveyances across the aqueduct such as overchutes or culverts that intersect runoff, channeling it across the SLC. Instead, the SLC was built with drain inlets to convey floodwater directly into the aqueduct. The cost of adding drainage conveyances was considered too expensive and any runoff was additional supply. Although there was a good deal of debate between the State and USBR at the time, the federal bureau prevailed. The debate took place in the 1960s, well before drinking water issues were at the forefront.

Figure 8-9 California Aqueduct: The San Luis Canal

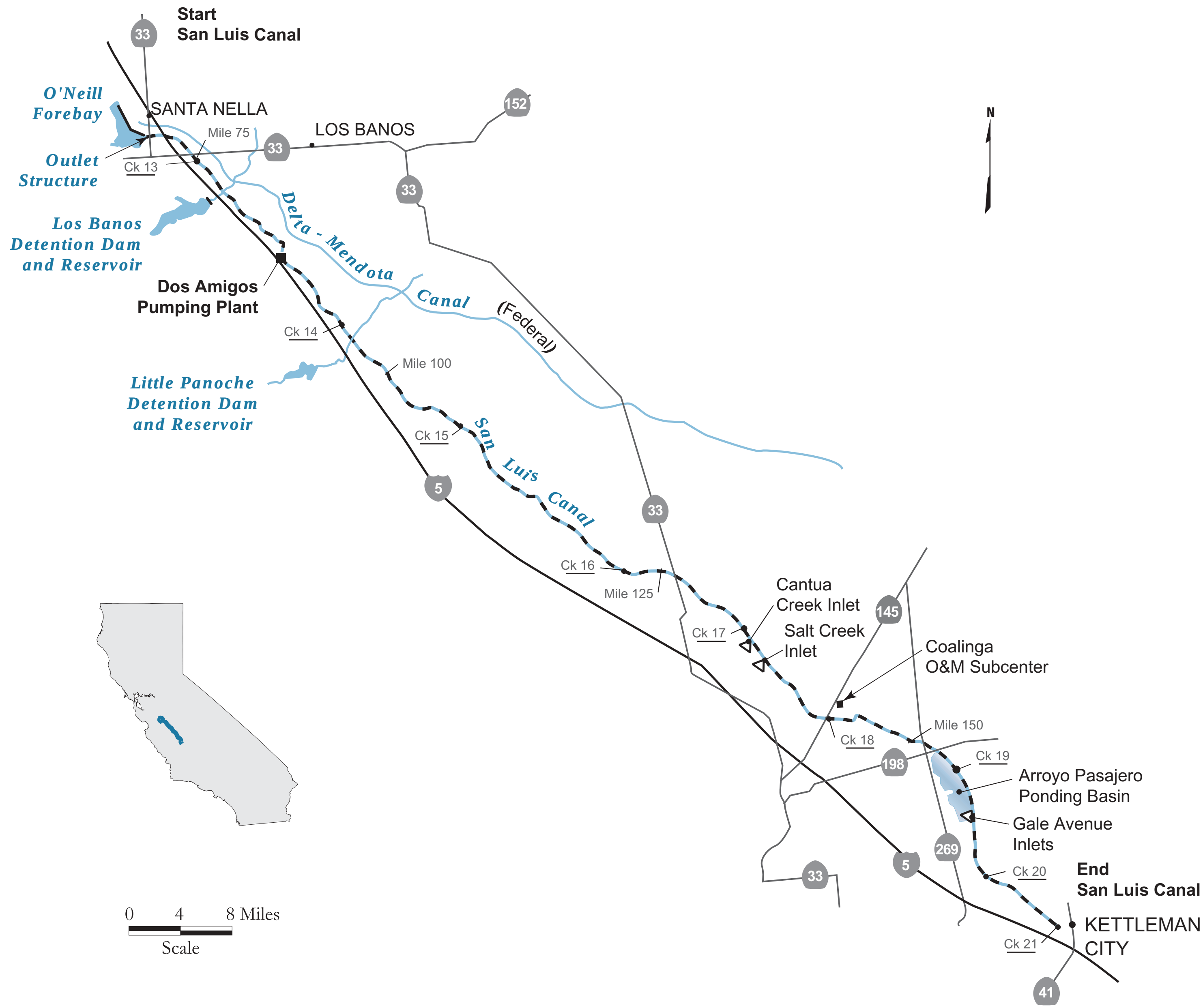


Table 8-9 Inflow Structures on the SLC (Drain inlets or other)[a]

Structure	Number
Toe drains for canal operating road and/or canal right of way	352
Drain inlets (DIs) for canal right of way and upslope rangeland	17
DIs for canal right of way and upslope cropland[b]	37
DIs for canal right of way and public roads or highways	1
DIs for off-site facilities such as water district pump stations	2
Little Panoche Creek	1
Cantua Creek	2
Salt Creek	1
Arroyo Pasajero	4
Pump pads for portable storm water runoff pumping	35

[a] From a DWR memorandum from D. Buchan to D. Kurosaka, "Drainage into the California Aqueduct." 1992.

[b] Eighteen of these inlets are gated; 1 can receive stop-logs. The inlets are closed during the irrigation season and opened during the rainy season. Those inlets without controls are said to be elevated above grade so that a certain amount of ponding is required before runoff is taken into the canal.

The San Luis Field Division's Joint-Use Facilities, which includes the SLC, are the integrated works of the USBR's Central Valley Project (CVP) and the SWP. The CVP provides water to an agricultural service area of more than 500,000 acres along the west side of the San Joaquin Valley. The service was intended to reduce the need to pump from deep aquifers, which was causing groundwater overdraft and regional land subsidence. The State's portion of conveyed water continues south past Check 21 in the California Aqueduct. Maintenance and operation of the SLC is the responsibility of the State with a cost sharing percentage of approximately 55% State and 45% federal.

8.3.1.1 Description of Aqueduct and SWP Facilities

The major facilities that make up the SLC include Dos Amigos Pumping Plant (mile 86.73) and 2 sections of canal. The 2 sections include a 16-mile section from O'Neill Forebay to the Dos Amigos Pumping Plant and an 85-mile section from Dos Amigos to the southern end of the canal at Check 21.

There are more than 60 drain inlets in the SLC that accept floodwater from the Diablo Range (Table 8-9).

The largest of these are Arroyo Pasajero and Little Panoche, Salt, and Cantua creeks. Runoff from adjacent operating roads and canal right of way is also conveyed into the SLC by 352 toe drains. There are 35 pump pads on the SLC. Pump pads are parkways designed to allow portable pumps to pump floodwater into the SLC without impeding traffic on the canal's operating road. The physical and water quality characteristics of drain inlets are discussed later in this chapter.

Numerous structures on the SLC are not related to conveying floodwater into the aqueduct, including bridges, pipeline crossings, and water service turnouts (Table 8-10).

Table 8-10 Nondrain Inlet Structures on the San Luis Canal [a]

Structure	Number
Bridges	47
State	5
County	39
Farm or private	3
Overcrossings	53
Pipelines	53
Overchutes	0
Undercrossings	73
Evacuation culverts	3
Irrigation or domestic water	70
Siphon (Panoche Creek)	1
Water service turnouts	128
Irrigation pumped upslope[b]	106
Other	22
Fishing areas[c]	14
Submersible pumps for relieving canal seepage and/or groundwater pressure against the lining.	45
Submersible pumps for intercepting seepage downslope from the canal	1
Vertical pumps for intercepting seepage from a slope stability trench	2

[a] From Brown and Caldwell 1990

[b] From DWR 1994, *Analysis of water quality impacts from ground water pump-in on the State Water Project, 1990-92*. Feb.

[c] Ten of these sites have toilets, generally portable chemical type. The rest have no sanitary facilities.

Four structures on the SLC were built to keep Diablo Range floodwater out of the aqueduct. These include 3 drainage undercrossings, or evacuation culverts, and a siphon at Panoche Creek (their exact locations are discussed later). The siphon is a large 4-barreled conveyance structure that allows Panoche Creek to flow naturally over the SLC, preventing any commingling of water. The original design to exclude Panoche Creek was due, in part, to a number of hard rock and mercury mines in the upstream watershed. There are no overchutes on the SLC.

Groundwater can be pumped into the SLC from 106 agricultural water service turnouts (Table 8-10). Pump-ins from these sources have been allowed in the past because of drought conditions. Pump-ins occurred from 1990 to 1996, assisting State and federal water contractors during periods of entitlement deficiency caused, in part, by the 1987 to 1992 drought. Groundwater can also be pumped into the SLC via DWR sump pumps, automated groundwater pumps that relieve pressure on the upslope, or western side, of the canal liner (Table 8-10). These waters are discussed further in Section 8.3.3, Potential Contaminant Sources.

8.3.1.2 Description of Agencies Using SWP Water

There are no SWP contractors taking water from the SLC; only federal CVP contractors. Most of the water diverted out of the SLC is used for agricultural purposes. The 2 largest diverters are the water districts of San Luis and Westlands. A small amount of domestic water is taken by the cities of Coalinga, Huron, and Avenal. Their turnouts are located at miles 143.16, 156.34, and 164.79, respectively.

Previous sanitary surveys identified many PCSs to the SLC. These included bridges, overcrossings, water service turnouts, fishing, and accidental spills. However, the largest PCS to the SLC is floodwater inflows. Following is a general description of all floodwater inflows. Specific PCSs within each watershed are listed after this description.

8.3.2 Watershed Description

Floodwater inflows to the SLC originate as rainfall runoff from the eastern flank of the Diablo Range. The Diablo Range extends from San Francisco Bay to Polomo Creek, south of Kettleman City (Davis 1961). The topography varies from mildly sloped foothills to rugged and steeply sloped mountains making up the headwaters. The geology of the Diablo Range is dominated by marine sandstone containing continental and ancient ocean deposits (Davis and others 1959). The SLC is situated on mildly sloped foothills and, to some extent, alluvial deposits originating from historical erosion and mass wasting. A more detailed description of Diablo Range geology as it pertains to water quality is presented in the Section 8.3.3.14, Geologic Hazards.

Twenty-three semidistinct watersheds drain toward the SLC and range in size from 7 square miles to more than 500 square miles, the largest being the Arroyo Pasajero at 539 square miles and Panoche Creek at 302 square miles (Figure 8-10 and Table 8-11). They are semidistinct because many of the streambeds intersect as they approach the aqueduct. Streams can often commingle on the flatter portions of land before ponding against the aqueduct. One example of this is Salt Creek and the Jordan Group. The 2 drain inlets are about 2 miles apart on the aqueduct, but their mineralogical makeup is oftentimes identical, indicating commingling (DWR 2000).

Figure 8-10 General Schematic of the San Luis Canal with Drain Inlet Numbers

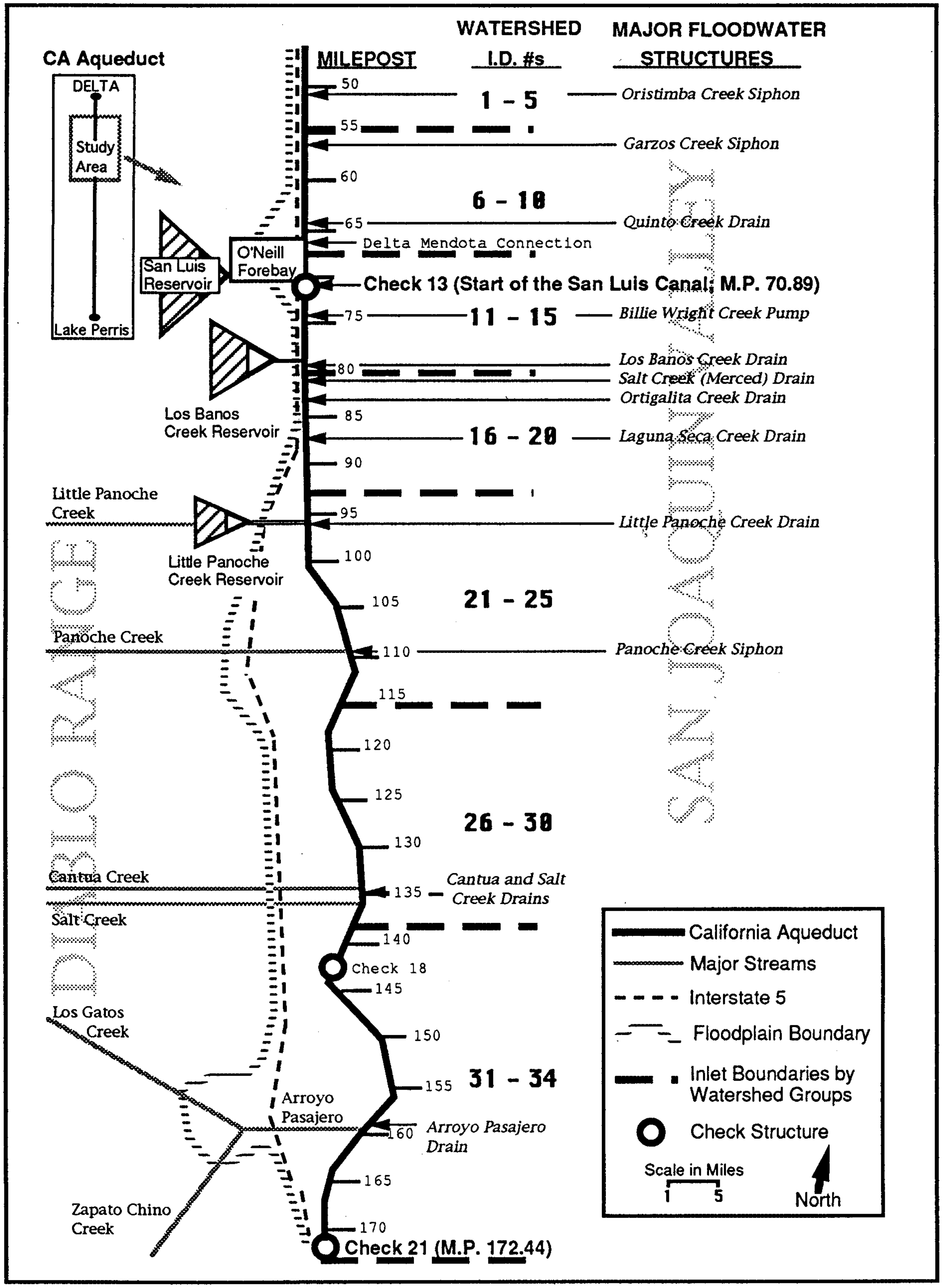


Table 8-11 Watersheds West of the San Luis Canal

Watershed[a]				
ID # [b]	Milepost Range	Name	Square Miles	Major Drainages and Their Tributaries
11	70.60 – 74.10	O'Neill Forebay drng, S.		
12	74.10 – 74.80	Billie Wright drainage	25[c]	Billie Wright Creek
13	74.80 – 78.36	Volta Group		
14	78.36 – 79.50	Los Banos Creek	157	Los Banos Creek: Los Banos Reservoir: N. & S. Forks Los Banos Crk., Wildcat Crk.
15	79.50 – 82.00	Salt Creek Grp (Merced Co.)	22	Salt Creek
16	82.00 – 84.40	Ortigalita Creek Group	57	Ortigalita Creek: Piedra Azul Creek
17	84.40 – 87.78	Dos Amigos	14	
18	87.78 – 89.55	Laguna Seca Creek	11	
19	89.55 – 93.70	Etoheverry Group	7	Laguna Seca Creek
20	93.70 – 95.40	Wildcat Canyon	20	Wildcat Canyon
21	95.40 – 96.78	Little Panoche Creek	101	Little Panoche Creek: Little Panoche Reservoir: Vasquez Crk., Mercey Crk., Mine Crk.
22	96.78 – 108.50	Panoche Hills Group	75	Capita Canyon. Moreno Gulch
23	108.50 – 110.85	Panoche Creek	302	Panoche Creek (Siphon): Las Aquilas Crk., Bitterwater Canyon, Clough Canyon,
24	110.85 – 113.82	Tumey Hills Group	29	Tumey Gulch
25	113.82 – 119.50	Monocline Ridge Group	50	
26	119.50 – 127.90	Arroyo Ciervo Group	8	Arroyo Ciervo
27	127.90 – 131.55	Arroyo Hondo Group	26	Arroyo Hondo
28	131.55 – 134.88	Cantua Creek Group	48	Cantua Creek: Arroyo Leona
29	134.88 – 138.24	Salt Creek Grp (Fresno Co.)	25	Salt Creek: Martinez Creek
30	138.24 – 141.90	Jordan Group	11	Domengine Creek
31	141.90 – 144.70	Ford Group	20	
32	144.70 – 154.11	Skunk Hollow	12	
33	154.11 – 163.95	Arroyo Pasajero	539	Arroyo Pasajero: Los Gatos Creek: Bear Canyon, White Crk., Mud Run, Nunez Canyon, Salt Canyon, Warthen Crk., Jacolitos Crk. Zapato Chino Creek: Cedar Canyon, Garcia Canyon, Canoas Crk.
34	163.95 – 172.44	Kettleman Hills Group		Arroyo Largo: Arroyo Torcido

[a] Refer to Figure 8-10 for areal location.
[b] ID # = Identification number assigned to the watershed.
[c] Combined area from O'Neill Forebay drainage (South), Billie Wright drainage, and the Volta Group.

Most streams draining toward the SLC can be classified as either ephemeral streams in interfan areas or larger intermittent streams that have created the major alluvial fans (Bull 1964). Intermittent streams such as Panoche and Los Gatos creeks receive groundwater flow along their entire length for weeks or months after the rainy season. Ephemeral streams drain the smaller gullies and usually flow only as a result of high precipitation.

Land use in the hilly or mountainous portions of the Diablo Range is predominantly unconfined animal rangeland and wilderness. Agriculture dominates land use on the floodplain or less hilly portions. Cotton made up the single largest land use in this area with 30%, followed by tomatoes (15%), fallow and idle (14%), and other truck crops such as lettuce and melons (14%). Most orchards were either almond or pistachio and accounted for almost 7% of all agriculture. Note that these numbers are for land use within the boundaries of the agricultural use area, and do not include the hilly or mountainous areas. More information on crop designations is presented in section 8.3.3.7, Agricultural Activities, under Potential Contaminant Sources.

Less than 3% of the land within the agricultural use area is classified as urban. The largest cities west of the SLC are Coalinga and Huron; both are in the Arroyo Pasajero watershed.

8.3.3 Potential Contaminant Sources

8.3.3.1 Floodwater Inflows

The SLC was built with drain inlets to convey west-side floodwater into the aqueduct. There are more than 60 of these drains ranging in size from 6-inch pipes to a new 550-foot concrete flume near Salt Creek. The majority are 24-inch to 48-inch pipes (Table 8-12). Smaller pipes draining adjacent service roads (called toe drains) were not included in this estimate.There are also 34 established pump pads to handle floodwater that ponds against the aqueduct levee. Pump pads are used in conjunction with portable pumps between Little Panoche Creek and Arroyo Pasajero, where ponding against the levee is common. With the exception of Salt and Cantua creeks, this section is not extensively equipped with drain inlets. Farmers pump water that ponds against the levee in preparation for planting. Water is also pumped to protect the levee from erosion-causing wind fetch. Portable pumps can, in fact, be used anywhere along the aqueduct. Pumps on wheels are equipped with long hoses to access the ponded water. Both DWR and private landowners own and use portable pumps, although landowners do most of the pumping.

Table 8-12 Floodwater Structures on the San Luis Canal[a]

Watershed			Drain Inlets			Bypasses		Pumps [e]		
ID # [b]	Milepost Range	Name	No.[c]	Opening size (ft^2)	% of total.[d]	No. [c]	Size (ft^2)	Sump	Pad	Perm
11	70.60 - 74.10	O'Neill Forebay drng, S.	6	32	(10)	1	30	0	0	4
12	74.10 - 74.80	Billie Wright drainage	0	0	(10)	1	30	0	0	1
13	74.80 - 78.36	Volta Group	8	57	(16)	0	0	8	0	0
14	78.36 - 79.50	Los Banos Creek	0	0	(16)	1	180	0	0	0
15	79.50 - 82.00	Salt Creek Grp (Merced Co.)	4	68	(23)	0	0	0	0	0
16	82.00 - 84.40	Ortigalita Creek Group	4	67	(29)	0	0	0	0	0
17	84.40 - 87.78	Dos Amigos	6	64	(35)	0	0	0	0	1
18	87.78 - 89.55	Laguna Seca Creek	3	94	(45)	0	0	0	0	0
19	89.55 - 93.70	Etoheverry Group	3	92	(54)	0	0	0	0	0
20	93.70 - 95.40	Wildcat Canyon	0	0	(54)	0	0	0	0	0
21	95.40 - 96.78	Little Panoche Creek	2	140	(68)	1	90	0	0	0
22	96.78 - 108.50	Panoche Hills Group	2	13	(69)	0	0	0	2	0
23	108.50 - 110.85	Panoche Creek	0	0	(69)	1	siphon	0	0	0
24	110.85 - 113.82	Tumey Hills Group	0	0	(69)	0	0	0	2	0
25	113.82 - 119.50	Monocline Ridge Group	0	0	(69)	0	0	0	4	0
26	119.50 - 127.90	Arroyo Ciervo Group	0	0	(69)	0	0	0	9	0
27	127.90 - 131.55	Arroyo Hondo Group	0	0	(69)	0	0	0	2	0
28	131.55 - 134.88	Cantua Creek Group	3	162	(85)	0	0	0	0	0
29	134.88 - 138.24	Salt Creek Grp (Fresno Co.)	3	23	(87)	0	0	0	1	0
30	138.24 - 141.90	Jordan Group	0	0	(87)	0	0	0	3	0
31	141.90 - 144.70	Ford Group	0	0	(87)	0	0	0	3	0
32	144.70 - 154.11	Skunk Hollow	0	0	(87)	0	0	0	4	0
33	154.11 - 163.95	Arroyo Pasajero	4	80	(95)	1	60	0	3	0
34	163.95 - 172.58	Kettleman Hills Group	12	49	(100)	0	0	0	1	0
		Total	60	941		6		8	34	6

[a] Adapted from San Luis Field Division Water Operations Manual OP-350R, Jun 1989.
[b] Refer to Figure 8-10 for areal location.
[c] Number of drain inlets or bypasses within each milepost range.
[d] Cumulative percent-of-total of the drain inlet opening size.
[e] Sump pumps, pump pads, and permanent pumps.

Figure 8-11 Annual Floodwater Inflow Volumes, 1973-1999

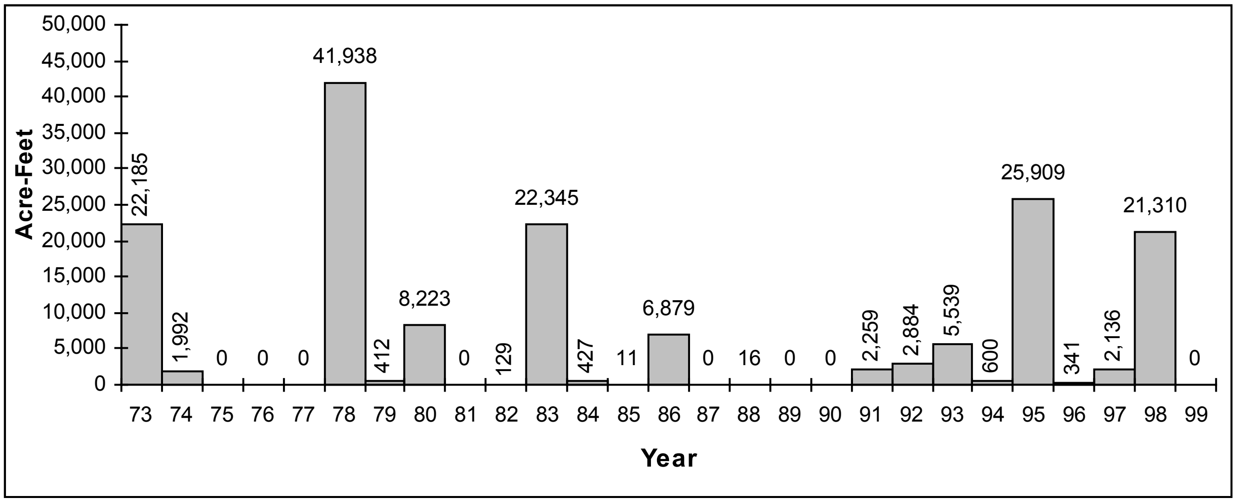
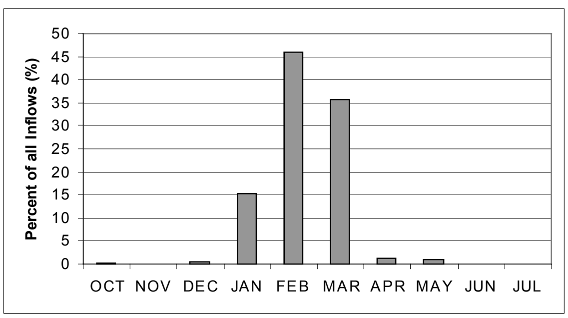


Figure 8-12 Relative Monthly Floodwater Inflows in Percent, 1973-1999



Floodwater has been admitted to the SLC in 19 out of 27 years with the largest inflows occurring in 1973 (22,186 af), 1978 (41,938 af), 1983 (22,345 af), 1995 (25,909 af), and 1998 (21,310 af) (Figure 8-11). Although inflows were admitted to the SLC prior to 1973 (1968 was a very large inflow year), accurate records were not kept.

Most inflows occur from January through March (Figure 8-12). A little less than half of all inflows have occurred in February. Inflows during January and March accounted for 15% and 36%, respectively. In 1998, inflows occurred during June and July for the 1st time ever. Inflows are rare during October and May and nonexistent in November.

Following is a brief description of the major drain inlets and any important features. An extensive amount of information exists for Arroyo Pasajero. It is summarized here because it is relevant to DWR's history of addressing impacts from floodwater inflows. Individual PCSs associated with the watersheds follow along with floodwater quality.

Little Panoche Creek

Little Panoche Creek intersects the SLC at mile 97 (Figure 8-10). There is a 5-by-6-foot box culvert to route flows under the canal to a ponding basin on the east, or downslope, side of the aqueduct. The ponding basin was built to prevent water from entering agricultural property. Farmers on the eastern side of the aqueduct consider the creek's mineralogy to be undesirable for growing crops and do not use the water even when flow continues into summer. During heavy runoff events, the basin fills up, and flows are diverted to another basin on the western side of the aqueduct, in front of the drain inlet structure. When this basin fills, water is admitted to the aqueduct via a 4-by-5-foot inlet structure. The structure is equipped with slide gates to control inflow volumes and limit the amount of sediment discharged. When a sufficient amount of sediment has settled out in the ponding basin, the slide gates are lowered to decant floodwater into the aqueduct.

In the upstream watershed, Little Panoche Creek Detention Dam was constructed to detain watershed runoff. Discharge from the outlet works is uncontrolled and begins when the surface elevation reaches a certain level. Discharge over the spillway is also uncontrolled and begins when the reservoir level exceeds 641 feet.

Inflow to the SLC from Little Panoche Creek has occurred in 7 of 27 years between 1973 and 1999 (Table 8-13). In 1998, rainfall in the Little Panoche Creek watershed was unusually high, and the capacities of both the upstream dam and ponding basins were exceeded, resulting in discharge of 6,092 af to the SLC, the highest annual volume on record from this source (Table 8-13).

Table 8-13 Floodwater Inflow by Drain Inlet, 1973-1999 (acre-feet)[a]

Year	Little Panoche Creek	Cantua Creek	Salt Creek[b]	Arroyo Pasajero	Other Drain Inlet[c]	Floodwater Pump-ins[d]	Breach	Total
1973	1,144			8,417	12,624			22,185
1974				1,992				1,992
1975								0
1976								0
1977								0
1978	3,034	1,985	197	35,035		1,687		41,938
1979				412				412
1980	633	489	256	6,259		586		8,223
1981								0
1982		124	5					129
1983	5,029	4,923	598	9,951	121	1,723		22,345
1984			114			313		427
1985						11		11
1986		4,268	333	2,278				6,879
1987								0
1988			15		1			16
1989								0
1990								0
1991		1,890	296			73		2,259
1992		1,531	518		287	548		2,884
1993		4,520	676		125	218		5,539
1994		62	118		70	350		600
1995	1,184	9,689	1,704	4,144	103	2,182	5,010	25,909
1996		288	51		2			341
1997	203	1,369	305		60	199		2,136
1998	6,092	6,506	1,162	2,278	3,694	1,446	132	21,310
1999								0
TOTAL	17,319	37,644	6,348	70,766	17,087	9,336	5,142	163,642
Percent (all)	11	23	4	43	10	6	3	
% (1973 to 1985)	10	8	1	64	13	4	0	
% (1986 to 1999)	11	46	8	13	7	8	8	

[a] Inflow data was taken from monthly tables or annual reports provided by San Luis Field Division. Although floodwaters were admitted prior to 1973, accurate records were not kept.
[b] Fresno County.
[c] Includes all other passive inflows from smaller drain inlets (DIs).
[d] Includes water pumped in from portable floodwater pumps.

Cantua Creek

Inflow from this watershed is admitted through a 10-by-6-foot concrete flume at mile 134.81 (Figure 8-10). A secondary inflow structure is upstream at mile 133.67 (6-by-4-foot concrete flume). This portion of aqueduct was damaged in 1995 when floodwater exceeded the capacity of both inlets, overtopping the canal levee. The aqueduct's concrete liner was either cracked or displaced for a section of almost 300 feet. Along with repairing the liner in 1996 and 1999, workers dug a small ponding basin against the levee. Further, a larger drain inlet was built south of the main inlet (mile 135) to handle excess floodwater from both Cantua and Salt creeks.

Inflow from Cantua Creek has occurred in 13 of 27 years between 1973 and 1999. Cantua Creek has been the single largest floodwater source in recent years. Table 8-13 shows that between 1986 and 1999, 44% of all floodwater originated from this watershed. Arroyo Pasajero has historically been the largest single source, but operational modifications have reduced its contributions (see Arroyo Pasajero below).

Salt Creek

Salt Creek intersects the SLC near mile 136 (Figure 8-10). The main inlet structure had been a 48-inch opening in the liner, with 1 or 2 smaller drains nearby. Similar to Cantua Creek, floodwater in 1995 caused major damage to the aqueduct at the Salt Creek drain inlet. A 550-foot concrete flume was installed in late 1999 to prevent this from occurring again. The new inlet at mile 135 is capable of handling floodwater from both Salt and Cantua creeks.

Inflow from Salt Creek has occurred during 15 of 27 years between 1973 and 1999 (Table 8-13). These inflows have accounted for 8% of the total during 1986 to 1999. Although Salt Creek inflows are secondary in volume to the other major drains, they have some of the highest levels of suspended solids measured in floodwater (see Section 8.3.4, Water Quality Summary).

Arroyo Pasajero

Arroyo Pasajero is the most studied of all SLC watersheds. It has a 540 square mile watershed with 4 main tributaries: Los Gatos, Jacolitos, Warthan, and Zapato Chino creeks (Figure 8-13).

The drain inlet at mile 158 is composed of 4 gated structures capable of admitting up to 3,500 cubic feet per second (cfs) into the SLC. During construction of the aqueduct, a 16,500 af ponding basin was incorporated into the design to capture runoff for evaporation and percolation. Because of sedimentation, the current capacity of the ponding basin is less than one-fourth the original capacity. An evacuation culvert at mile 155.73 was also included in the original design to pass a maximum of 1,100 cfs beneath the canal, mostly to farmland on the eastern side. Use of this structure had been limited in the past because of downstream flooding at Lemoore Naval Air Station. All of these features were designed in the mid-1960s prior to the construction of the SLC. Floodwaters that occurred over the next 30-plus years showed the original design to be seriously inadequate. Floodwater and sediment volumes proved to be 4-to-6 times those estimated in design.

Prior to 1986, Arroyo Pasajero had been the single largest floodwater source to the SLC. From 1973 to 1985, Arroyo Pasajero contributed 64% of all SLC floodwater, largely due to unusually high inflows in 1978. Inflows in 1980 and 1983, and the corresponding detection of asbestos in the aqueduct below Arroyo Pasajero, resulted in a change in operating procedures. In 1985, Standing Order No. SLFD-OP-85-8B was approved to coordinate the operation of the drain inlet gates to optimize ponding capacity.

In short, inflows were to be admitted to the SLC only when ponding areas north and south of Gale Avenue had been filled (Figure 8-13). This differed from previous operations where only DWR-owned land north of Gale Avenue was used. The new ponding area increased storage capacity by 42,650 af but flooded privately owned cropland. Periodic flooding of this land in the following years led to lawsuits and subsequent monetary restitution. A decantation weir was built around the drain inlet to further reduce sediment loads. The weir is a gabion-mesh structure that acts as a porous dam to slow the flow of water before it is released to the SLC. After 1985, only 13% of all floodwater originated from this watershed (Table 8-13).

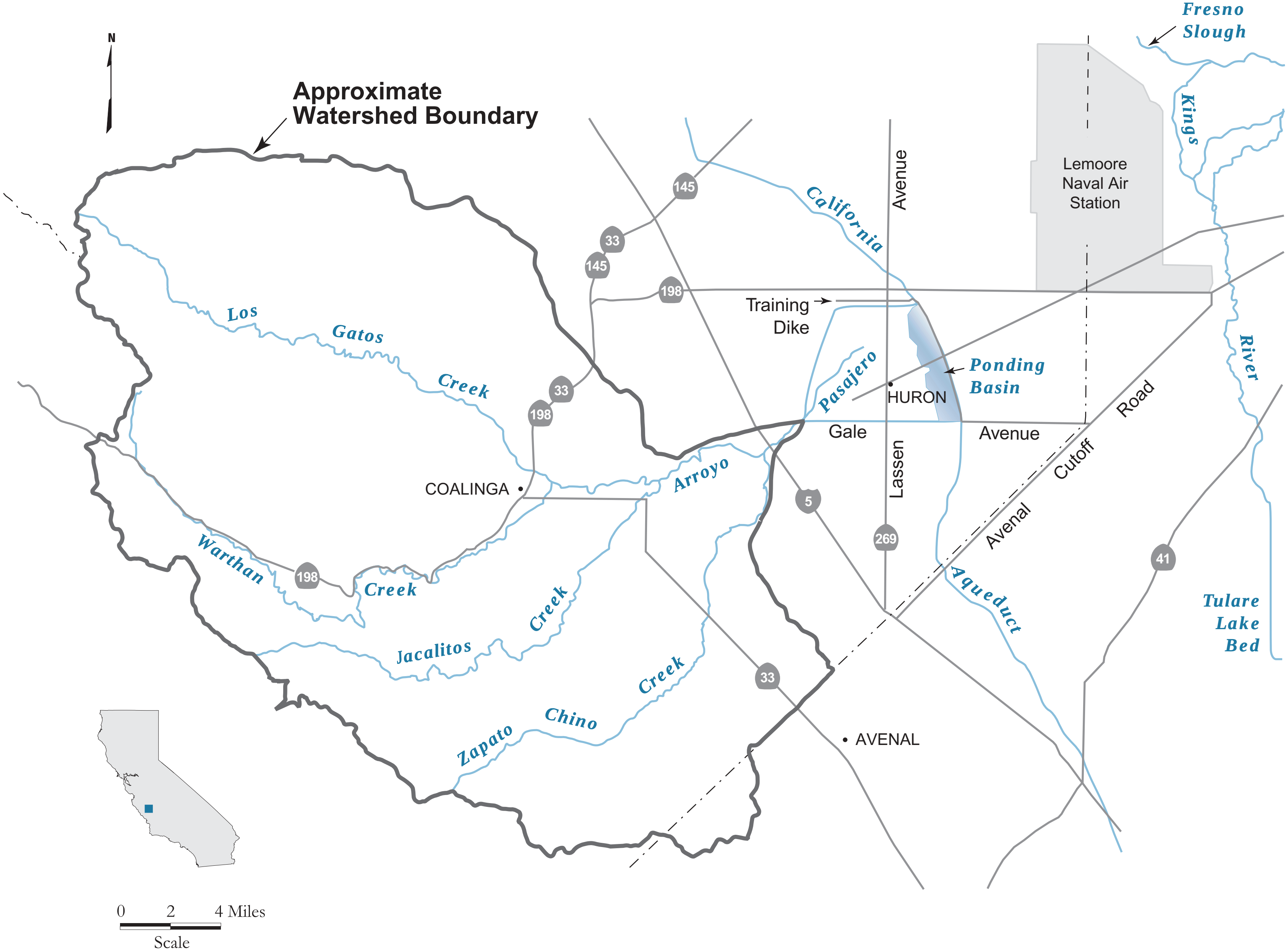


Figure 8-13 Arroyo Pasajero Watershed

In the early 1980s, MWDSC expressed concern about asbestos detected in the aqueduct downstream from Arroyo Pasajero and in the watershed's ponding basin. MWDSC was concerned about potential human health threat of asbestos-laden sediment entering a major drinking water source. Initially, the asbestos was thought to originate from 2 abandoned asbestos mines in the upstream watershed. The Coalinga (Johns-Manville) and Atlas mines are both in the Los Gatos Creek watershed, a tributary of Arroyo Pasajero. Commercial production ceased in the mid to late 1970s followed by hazardous waste listings in 1984. The US Environmental Protection Agency (EPA) listed both mines as Superfund sites because of their potential release of asbestos into both the air and water. An asbestos-processing site near the city of Coalinga was also listed.

Both the Coalinga Mine and the city of Coalinga Unit were remediated in 1993 and deleted from the National Priorities List in 1998. Any site deleted from this list remains eligible for further cleanup if necessary. Both sites will be monitored every 5 years to ensure cleanup measures remain in place. The Atlas Mine remains on EPA's priority list because of stunted revegetation efforts. These efforts are described in Section 8.3.6.1, Abandoned Mine Remediation. Regardless of the remediation efforts, natural sources of asbestos can still be flushed downstream.

Naturally occurring serpentinite in the Los Gatos Creek watershed still remains a major source of asbestos. The asbestos-containing outcrops extend well beyond the boundaries of the abandoned asbestos mines and are part of the New Idria Formation (USACE 1999). The uplift and erosion of the New Idria Formation has been ongoing for more than 15 million years and has resulted in the prevalence of naturally occurring asbestos in sediments of Arroyo Pasajero's alluvial fan. There are more than 65 square miles of naturally occurring soils and outcrops that contain 30% by volume, or more, asbestos. The entire area is within US Bureau of Land Management's (BLM) Clear Creek Management Area, but not all of it is within the Los Gatos Creek watershed (DWR 1997). BLM has designated most of this land as an asbestos hazard, and posted signs warn people of the health threat. The exposed serpentine is so prolific that 1 of the creeks draining the area was named White Creek because during significant storms the creek flowed milky white with asbestos and left a white coating on streambanks (DWR 1990).

These natural sources have been determined to contribute the bulk of asbestos carried down into Arroyo Pasajero. Prior to remediation efforts at the mines, EPA concluded that most asbestos in Arroyo Pasajero was from naturally occurring sources (Levine-Friecke 1989). Only 0.3% to 1.6% was estimated to originate from the upstream abandoned mines. Although natural sources of asbestos are elevated in this watershed (and other watersheds with serpentinite outcrops), the human health implications for SWP water containing Arroyo Pasajero inflows may not be as critical as earlier thought. The relative threat of asbestos from Arroyo Pasajero is discussed in section 8.3.5.2 under Significance of Potential Contaminant Sources.

During the 1990s DWR continued to address impacts from Arroyo Pasajero. In 1991, at the request of the State Water Contractors, DWR enlisted the US Army Corp of Engineers (USACE) and USBR to conduct a basinwide study of Arroyo Pasajero. The goal was to find a solution to the problem using the environmental impact report/environmental impact statement (EIR/EIS) process (feasibility report). Standing Order SLFD-OP-93-8D was approved in 1993 as an interim measure pending completion of this report. Briefly, the order states that both the ponding basin and evacuation culvert, are to be used before any runoff is admitted to the aqueduct. If after opening the culvert, levels in the basin continue to rise and threaten to breach the levee, floodwater would be admitted to the aqueduct. Prior to this, the culvert had not been routinely used due, in part, to the threat of lawsuits from downstream landowners. In 1995, the culvert was opened and downstream agricultural property was flooded. Afterwards, a lawsuit was filed against the State for financial losses. However, the suit was dropped when the Attorney General's Office argued that the SLC provided a net benefit to agribusiness, offsetting any negative impacts.

In March 1995 floodwater also ruptured a live oil pipeline, and 4,400 barrels of oil were released 4 miles upstream from the aqueduct (Figure 8-14). Although the ponding basin held much of the oil-water mixture, a breach in the aqueduct levee occurred on the same day, releasing about 5,000 af of this water to the SLC. Because of rising levels in the ponding basin along with a power outage that prevented opening of the evacuation culvert, the drain inlets were open at the time of the spill and also draining floodwater to the SLC. An attempt was made to close the inlet gates when the oil release was discovered. However, 1 gate could not be closed because of an 18-inch log. Attempts were made to stop the inflow by progressively dumping a combination of stop-logs, rocks, and gravel in front of the inlet gates. Flow was stopped 3 days later. Water quality monitoring showed that some oil entered the aqueduct (DWR 1996). Other problems caused by the March 1995 floods included destruction of a bridge on Interstate Highway 5 (resulting in 7 deaths), dislocation of railroad tracks, and closure for 2-½ months of Lassen Avenue because of heavy sedimentation. Soon after, the State Water Commission requested DWR to form a multi-agency forum to solicit input from lawmakers, local government, citizens and others in determining a solution. As a result, DWR had to modify its *Arroyo Pasajero Feasibility Report* (started in 1991) to address the input. The report also had to account for record-breaking runoff in 1995 that changed the magnitude of future predicted storms.

In March 1999 DWR, in conjunction with the USACE and USBR, released the draft *Arroyo Pasajero Feasibility Investigation*, a detailed description of the problems and possible ways to address them (USACE 1999). Essentially, it was a full EIR/EIS that proposed 2 possible solutions: 1) a detention dam upstream or 2) greater ponding capacity against the aqueduct with overchutes.

The various interested parties rejected both proposals, prompting the development of a new solution. A new work plan was proposed in May 2000 that addressed all floodwater, not just that from Arroyo Pasajero. The SLC would be used as a conveyance to transport floodwater to a newly proposed waste way turnout. The turnout would divert floodwater to land purchased exclusively for ponding. More details are discussed in Section 8.3.6, Watershed Management Practices.

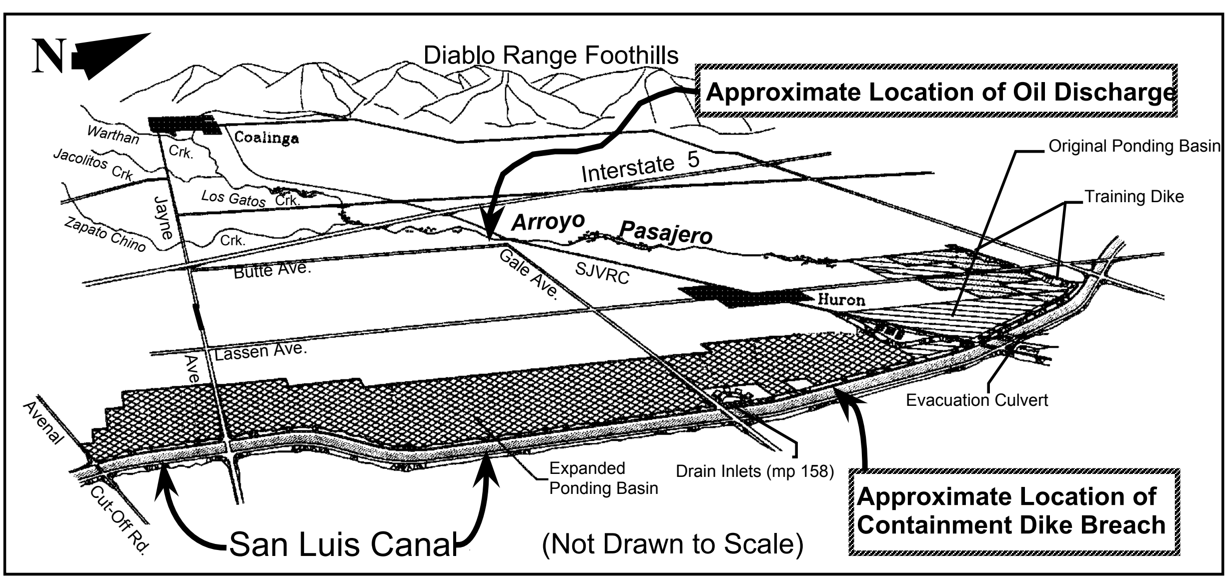
Los Banos Creek

As the 1995 rainy season progressed, continued rainfall was expected to produce uncontrolled releases from the Los Banos Creek Dam. Similar to Little Panoche Creek Dam, Los Banos Creek Dam was built to moderate floodwater so that the capacity of the evacuation culvert at mile 79 would not be exceeded (there are no drain inlets for this watershed). Uncontrolled releases from the upstream dam were forecast during the 1995 rainy season, posing a potential threat to the aqueduct. Under emergency conditions a temporary overflow weir was constructed to allow excess floodwater to sheet flow into the SLC. Essentially, a 500-foot section of canal levee was lowered by several feet and lined with Gunite to prevent erosion. Without this, overtopping of the unprotected levee could result in a major breach of the western and possibly eastern side of the aqueduct levee (as well as higher inflow volumes). Fortunately, levee overflows were averted by a change in the weather. However, the overflow weir remains a permanent feature of the SLC.

Toe Drains, Bridges, and Pipeline Overcrossings

These are smaller pipes that drain adjacent service roads. Many convey canal roadside drainage into the open canal sections when it rains. These drains could contribute sediment, and possibly herbicides used for weed control in the canal right of way, to the canal water. Several of the drains discharge runoff from major highways and could contribute metals, oil, and grease, as well as materials spilled from trucking accidents. There are an estimated 353 toe drains in the SLC. This estimate includes those that drain roads and highways (see Section 8.3.3.11, Transportation Corridors).

Figure 8-14 Location of the Containment Dike Breach and Oil Discharge in the Arroyo Pasajero Watershed



There are 47 bridges crossing the SLC. These consist of interstate and state highways, county roads, and farm bridges. Bridges offer easy access for illegal dumping and vandalism. Motor vehicle accidents can result in spills into the canal of petroleum products and potentially hazardous substances as well as the vehicle itself. Herbicides, pesticides, and fertilizers are frequently transported across the canal on farm bridges. Animal waste products can enter the water from cattle driven over the bridges. Drainage from the bridges flows into the canals in several locations. Bridges are also used to support pipeline crossings over the canals in many locations.

Pipeline overcrossings exist in numerous locations. Materials conveyed in the pipelines can include petroleum products, domestic water, and natural gas. Their relative threat to water quality was addressed in *Sanitary Survey 1990*.

These structures appear to pose only a minor threat to water quality.

8.3.3.2 Recreation

There are no recreation amenities on the SLC, although several locations are popular for fishing. A 1992 DWR survey identified 14 fishing sites, 10 with portable chemical toilets. The SLC can be fished anywhere public access is available. There is no contact recreation on the SLC, and numerous posted signs discourage swimming in the canal because of the inherent danger.

Noncontact recreation such as hunting and fishing is allowed at the reservoir of Little Panoche Creek Dam. The lake is administered by California State Parks. There are picnic areas and a boat launch but no camping. No signs are posted to discourage contact recreation. California State Parks does not keep visitor attendance records for this water body. The water quality threat from any recreational activities is expected to be minimal to nonexistent because summer flow from this reservoir is routed under the aqueduct.

8.3.3.3 Wastewater Treatment Facilities

There are 3 wastewater treatment plants west of the SLC. They were evaluated by reviewing the files and talking with staff at Central Valley Regional Water Quality Control Board, Fresno Office (CVRWQCB).

City of Huron Wastewater Treatment Facility

This wastewater treatment plant (Waste Discharge Identification number (WDID #) 5D100107001) is about 1.5 miles from the aqueduct in the Arroyo Pasajero watershed. From 0.3 million to 0.6 million gallons per day (mgd) of treated domestic sewage is discharged to nearby ponds. The plant is near Arroyo Pasajero's ponding basin, but the sewage ponds are surrounded with a protective dike designed to prevent inundation. In 1997, the CVRWQCB identified permit violations for not maintaining a flowmeter, bar screens, and disposal ponds. The city responded that the flow recording equipment would be fixed, the screens were to be cleaned and would be operating, and weeds would be removed from the pond.

Harris Ranch

Harris Ranch Inc. operates a permitted packaged wastewater treatment plant. The plant treats domestic sewage from the Harris Ranch restaurant and hotel complex using activated sludge technology. The 30-day average design capacity of the plant is 65,000 gallons a day. The treated sewage is discharged to 4 evaporation/percolation ponds in the Skunk Hollow watershed. The plant is approximately 5 miles west of the aqueduct between miles 144 and 153. There are no drain inlets or sump pumps in this portion of aqueduct, although there are a number of pump pads. Ponded floodwater cannot migrate south past mile 153 because of Arroyo Pasajero's training dike that contains floodwater within a ponding basin. Land between the Harris plant and the SLC is primarily cropland.

The Harris Ranch complex is planned for expansion: a new car wash, recreational vehicle park, expansion of the hotel, a drive-up restaurant, a new 150-room economy motel, commercial service center, and increased parking for trucks, buses, and recreation vehicles. Expansion of the wastewater treatment plant is also proposed. The current mechanical plant would be replaced with an aerated lagoon system with more evaporation/percolation ponds. This system would be able to handle the expected increase in wastewater. The design flow during dry weather would be 100,000 gallons a day with a peak capacity of 300,000 gallons a day, typically needed on weekends during the tourist season.

A water balance was performed to design the size of the ponds. Ponding requirements were based on a 100-year return frequency rainfall interval and a wet year evaporation rate. The raw sewage would 1st flow through a series of screens to remove solids prior to ponding. The solids would be compacted, de-watered, and deposited in a bin for later transport to a landfill. The wastewater would continue to a series of ponds for treatment, percolation, and evaporation. The 1st pond is to be equipped with floating aerators to facilitate biological treatment and waste reduction. The stabilized wastewater will then flow to a polishing pond for further treatment and settling of suspended solids. The polishing pond will also serve as a standby if the aeration pond needs to be de-watered or cleaned. The polished water will then be sent to a series of 5 ponds with a combined capacity of nearly 8 million gallons. These shallow ponds will be used to percolate and evaporate the treated wastewater. They do not have to be lined because there is no shallow groundwater and no nearby domestic wells. The portion of aqueduct downstream from this plant is not equipped with sump pumps.

This expansion was proposed in early 1999, and the CVRWQCB approved it in June 2000. After the order is revised and approved by the State Water Resources Control Board (SWRCB), completion of the expanded facility is expected to take about 9 months.

Coalinga Wastewater Treatment Facility

This conventional wastewater plant (WDID # 5F10S011605) produces about 1.3 mgd of treated domestic sewage from the city of Coalinga. The discharge irrigates nearby farmland. Coalinga is in the Warthan Creek tributary of Arroyo Pasajero and is approximately 18 miles from the SLC.

These facilities appear to pose only a minor threat to water quality in the SLC.

8.3.3.4 Industrial Discharge to Land

PG&E Kettleman Compressor Station Class II Surface Impoundments

This facility (Order No. 99-145) maintains pressure in a natural gas pipeline. The compressors are cooled by water that is circulated through a cooling tower. From 1929 to 1989, the discharger operated 5 unlined surface impoundments for disposal of cooling tower blowdown and other minor facility wastewater streams. Maintenance activities included draining an on-site swimming pool, descaling copper-alloy cooling systems, and degreasing equipment. In 1989, the facility was permitted for the 1st time with a discharge to land permit (Waste Discharge Requirement or WDR). In 1994, the unlined impoundments were closed. The facility currently discharges an average of 38,000 gallons a day of nonhazardous wastewater to newly permitted class II surface impoundments constructed in accordance with Title 27 regulations. An inspection in 1999 reported no permit violations.

The facility is in the Kettleman Hills watershed, a little more than 2 miles from the aqueduct between miles 163 and 170. There are a number of drain inlets in this section of canal. Water quality samples collected from some of these inlets have exhibited elevated levels of metals and organic carbon (DWR 1995). It is unclear whether there is any relationship between these data and the permitted facility.

8.3.3.5 Industrial Site Stormwater Runoff

Several industries within the Arroyo Pasajero watershed are permitted for storm water runoff. They were evaluated by talking with CVRWQCB staff and reviewing their files.

Chemical Waste Management, Coalinga Transportation Facility

This is a truck maintenance yard (WDID # 5F10S005416) with diesel fuel tanks, motor and hydraulic oil containers, propane tanks, and waste oil tanks. The yard is within the city of Coalinga approximately 18 miles from the SLC. Although there were no data from past monitoring, the company applied for and received a Notice of Termination (NOT) for its storm water permit in 1999. The basis of the termination was that all storm water is retained on site. The CVRWQCB approved the termination and sent it to the SWRCB for final approval.

Chemical Waste Management, Coalinga Facility

This is an inactive class II waste disposal site (WDID # 5D100305001) just north of Coalinga. It was in operation between 1973 and 1984 and accepted primarily oil field-related wastes. These wastes consisted of drilling mud, scrubber waste, tank bottoms, waste brine from water softening units, oily wastes, and produced water. About 2.7 million barrels of this waste was accepted. The previous owner buried some restricted waste, but that was removed in 1984 with oversight from the CVRWQCB and DHS. In October 1997, the CVRWQCB determined that this facility presented no water quality threat to the beneficial uses of surface waters. It also presented a comparatively small threat to the underlying aquifer because naturally occurring salts render the groundwater unusable.

Artesia Ready Mix

This facility (WDID # 5F54S006290) is about 5 miles south of Coalinga within the Zapato Chino Creek watershed of Arroyo Pasajero. The facility makes ready-mixed concrete. No monitoring data were available.

Waste Management, Inc., Coalinga Treatment Facility

This is a “refuse systems waste treatment facility” (WDID # 5C10S011518) and is within the city of

Coalinga. A single water quality sample had been collected from the site during a rainfall event. The sample had relatively high levels of total suspended solids (4,240 mg/L) and conductivity (20,100 µS/cm). No other monitoring data or information was available.

Pool California Energy Services, Inc.

This company stores and maintains equipment used to service oil wells throughout Fresno County and surrounding areas (no WDID available). The operation is termed an "oil and gas field services facility" and is in Coalinga. In 1997, the company submitted its annual storm water report and stated that there had been no storm water discharges from the site. A 1-foot berm surrounds the property. Runoff is conveyed into a recessed area that is about 100 feet by 80 feet by 1 foot in size. No other information was available.

Coalinga-Huron Unified School District, Transportation Department

This is a school bus yard in Coalinga (WDID # 5F10S003915) where buses are parked, fueled, washed, and serviced. The yard contains diesel fuel tanks and new and used oil containers. Two runoff samples collected in 1999 contained oil and grease at <10 and 49 mg/L. Conductivity was below 100 µS/cm and total suspended solids (TSS) ranged from 11 to 18 mg/L.

City of Coalinga Wastewater Treatment Facility

This is a conventional wastewater plant in Coalinga (WDID # 5F10S011605). The facility requested and received, a Notice of Termination in August 1998. All runoff is now ponded on site.

It appears that none of the industrial sites poses a significant threat to water quality at this time.

8.3.3.6 Animal Populations

Livestock Grazing

Although no surveys have been performed, livestock grazing has been observed in most of the hilly areas west of the SLC. Grazing is not considered a significant threat to water quality at this time.

Confined Animal Facilities

Two confined animal facilities are west of the SLC. A review of CVRWQCB files located 1, and DWR staff identified the other.

Harris Feedlot

The Harris Feedlot is a sophisticated cattle-feeding operation that covers more than a square mile of land upstream from the SLC. In 1989, the number of cattle was estimated at 100,000 head. In the last few years, several corrals have been added, so the current population is probably higher. Runoff from the feedlot drains to a large catch basin that overflows into a series of evaporation ponds. The basins are a little more than a mile from the SLC, near mile 142 and 143. This section of aqueduct is not equipped with either drain inlets or sump pumps, although a pump pad is at mile 142.5. Ponded water cannot extend south of mile 143 because of Coalinga Canal.

In the past, dry manure was scraped from the corrals and transported to a processing area where it was stored before being sold. In the late 1980s, this process occurred on the property where the ponds are located. Berms had been constructed around the processing area to protect against flooding and overflow. No available information indicates whether manure is still processed on-site, and if so, where it occurs.

Rainfall runoff from the facility was thought to flow unimpeded toward the aqueduct. DWR's unofficial policy was to disallow any pumping of this water into the aqueduct for obvious reasons. Water ponded against the aqueduct could cause levee erosion from wind fetch. Because of DWR complaints, the CVRWQCB in 1988 requested Harris Ranch to rectify the problem. The ranch responded by enlarging the ponding basins and installing headgates on the collector dams for better control. The new capacity was 224 af, twice the amount of runoff expected for a 100-year, 24-hour storm. Although considered adequate at the time, weather changes since then have probably lessened the design capacity. Capacity may have also declined from sedimentation.

In addition to enlarging the ponds, Harris Ranch also cross-levied and bermed land below the primary and secondary catch basins to accommodate any emergency runoff. Theoretically, if the ponds overflowed, water would be diverted north to some temporary holding basins near mile 141.5. This water would be used to irrigate adjacent agricultural land or be pumped back to the western side of the aforementioned berm. It is unknown whether this emergency measure was ever used or if the diversion berm still exists.

More recently in 1995 USBR complained to the CVRWQCB about ponded water downstream of Harris Ranch. A subsequent inspection and discussions with a Harris Ranch representative indicated that the water originated from runoff north of the corrals. According to the inspection report, "Runoff simply flows around the north end of the corrals and down a field road to the aqueduct." It was implied that no runoff from the facility makes it to the aqueduct. The ponding basins were also inspected. The smaller of the 2 ponds—5 acres in size—was one-third to one-half full. Wastewater was trickling through the head gate of this pond into a 25-acre pond that was nearly empty. Apparently, the ponds were able to handle a high runoff year.

The Harris Ranch Feedlot is not permitted by the CVRWQCB because there are no permit requirements for operations that do not discharge storm water to surface waters or storm sewers. According to regulations, "To avoid liability, the discharger should be certain that a discharge of industrial storm water to surface waters will not occur under any circumstances."

Thommen Dairy

This dairy is approximately a quarter mile from the SLC in the Etoheverry Group watershed. There are a host of drain inlets along this section of canal, the nearest at miles 92.72 and 93.41. The 1st is a 4-by-4-foot concrete structure, and the 2nd is a 48-inch concrete pipe. Any potential runoff from the site would end up closer to the 92.72 inlet. There are no water quality data for either of these drain inlets.

CVRWQCB staff did not have any record or knowledge of this dairy. DWR staff confirmed its existence from a nearby road. DWR staff noted a pond on the downstream side of the property. Apparently, Fresno County does not require any permits for dairies on agricultural land, so they are not reported to the CVRWQCB unless there is a problem. Further, the CVRWQCB has been historically underfunded, and money specifically earmarked for dairy regulation has been virtually nonexistent (there was also a 20% vacancy rate at the CVRWQCB's Fresno Office at the time of this writing).

Wild Animal Populations

Land west of the SLC is prime habitat for wildlife, especially in the upper reaches of the watershed. A wildlife survey was performed in Arroyo Pasajero and probably reflects that of the other watersheds (USACE 1999). It identified several species of mammals, birds, and reptiles inhabiting the area around the confluence of Los Gatos and Warthan creeks and the ponding basin against the aqueduct. The most common mammals included jack rabbits, cottontails, kangaroo rats, skunks, and coyotes. Wildlife such as feral pigs, black tailed deer, and black bear probably inhabit the upper reaches of the watershed. Relative to confined animal facilities, this PCS is considered minor.

8.3.3.7 Agricultural Activities

Agricultural land uses such as field and truck crops, dominate the flatter portions of land west of the SLC (Table 8-14 and Figure 8-15). Cotton made up the single largest land use in this area with 30%, followed by tomatoes (15), fallow and idle (14), and other truck crops such as lettuce and melons (14). Most orchards were either almond or pistachio and accounted for almost 7% of the total agricultural land uses.Based on water quality analyses in floodwater inflows, pesticides and herbicides are applied to land west of the SLC. The most frequently detected compounds during 1996 to 1999 were cyanazine, dacthal, simazine, diazinon, methadathion, trifluralin, oxyfluorfen, and diuron. They are carried into the SLC during winter when pesticide applications are followed by rainfall runoff events (see Section 8.3.4, Water Quality Summary).

Although floodwater inflows contribute pesticides to the aqueduct, present-day pesticides are made to decay quickly in the environment. Further, most of the pesticides detected in the SLC originate from Delta exports (DWR 1995), so floodwater would only be contributing to levels already present in the aqueduct. In light of the fact that no pesticide MCLs were violated during 1996 to 1999, pesticides from floodwater are not considered a major concern in the SLC.

Table 8-14 Irrigated Land Uses West of the San Luis Canal, 1994-1995

Land Use [a]	Acres	Percent of Total
Subtropical	564	0.2
Pasture	608	0.2
Alfalfa	661	0.3
Corn	734	0.3
Nonirrigated Agricultural Land	2,089	0.8
Sugar Beets	2,391	0.9
Other Deciduous (apple, cherries, etc.)	2,553	1.0
Grapes	4,868	1.9
Other Field (flax, corn, etc.)	5,433	2.1
Urban	6,931	2.7
Almond and Pistachio	17,760	6.8
Grain	27,710	11.0
Other Truck (lettuce, melons, etc.)	35,310	14.0
Fallow and Idle	35,575	14.0
Tomatoes	38,021	15.0
Cotton	78,212	30.0
Total	259,420	100

[a] Covers only land that uses SWP water. Land use farther up the watershed is not included here.

8.3.3.8 Mines

One survey has collected data on potential mining activities west of the SLC, and it was done for Arroyo Pasajero (USACE 1999). County surveys identified many mineral resources in Arroyo Pasajero, but only sand and gravel was considered economically viable. Several inactive or abandoned asbestos mines are in the same watershed and could contribute asbestos and mercury in drainage entering the SLC.

The only other mine upstream of the SLC with a known water quality threat is New Idria Mine. The abandoned mine is in the upper reaches of Panoche Creek, which passes over the aqueduct via siphon, thereby preventing mine drainage from entering the aqueduct.

8.3.3.9 Solid or Hazardous Waste Disposal Facilities

Two waste disposal facilities operate within the SLC watershed. They were located by reviewing CVRWQCB files and talking with CVRWQCB staff.

Billie Wright

The Billie Wright solid waste municipal landfill (class III) is approximately 1.5 miles upstream from the SLC near mile 75. The landfill consists of 1 inactive and 1 active, unlined, waste management unit covering 3 and 30 acres, respectively. An additional 88 acres is to be added in a permit revision in latter part of 2001. A nearby ephemeral stream drains toward the aqueduct and is called Billie Wright Creek. The SLC is equipped with both a box culvert and a sump pump to pass this drainage under the canal or accept it into the aqueduct. Before 1992, the sump pump operated by float valve, periodically discharging drainage into the aqueduct. Groundwater accretion from this watershed has naturally elevated mineral levels such as TDS (average 6,500 mg/L), hardness (1,600 mg/L as $CaCO_3$), and selenium (0.182 mg/L). Because of this, the sump pump was disconnected in 1992. Since then, all flows pass under the SLC to the DMC where it also passes underneath to an almond orchard.

Blue Hills

The Blue Hills landfill was constructed in 1973 and accepted class I hazardous waste until it was closed in 1990. It is in the foothills of Skunk Hollow, about 10 miles from the SLC. An unnamed intermittent drainage traverses the landfill, but diversion structures have been built to convey flows around it. Any runoff from this area large enough to make it to the aqueduct would pond against the levee between miles 144 and 153. There are pump pads in this section of canal but no sump pumps or drain inlets.

Operated by Fresno County, the landfill had previously accepted pesticides, empty pesticide containers, and other agricultural industry-related hazardous and nonhazardous wastes. After closure, the facility was classified as a class III landfill containing hazardous waste in accordance with Title 23 of the California Code of Regulations. It is currently under a 1999 Post-Closure order that requires periodic inspections of the flood protection structures following all storm events as well as periodic groundwater monitoring. The last inspection in 1998 noted no problems, although low concentrations of herbicides were detected in the underlying groundwater. Fresno County is implementing a corrective action plan. The underlying groundwater is isolated and not connected to San Joaquin Valley aquifers to the east.

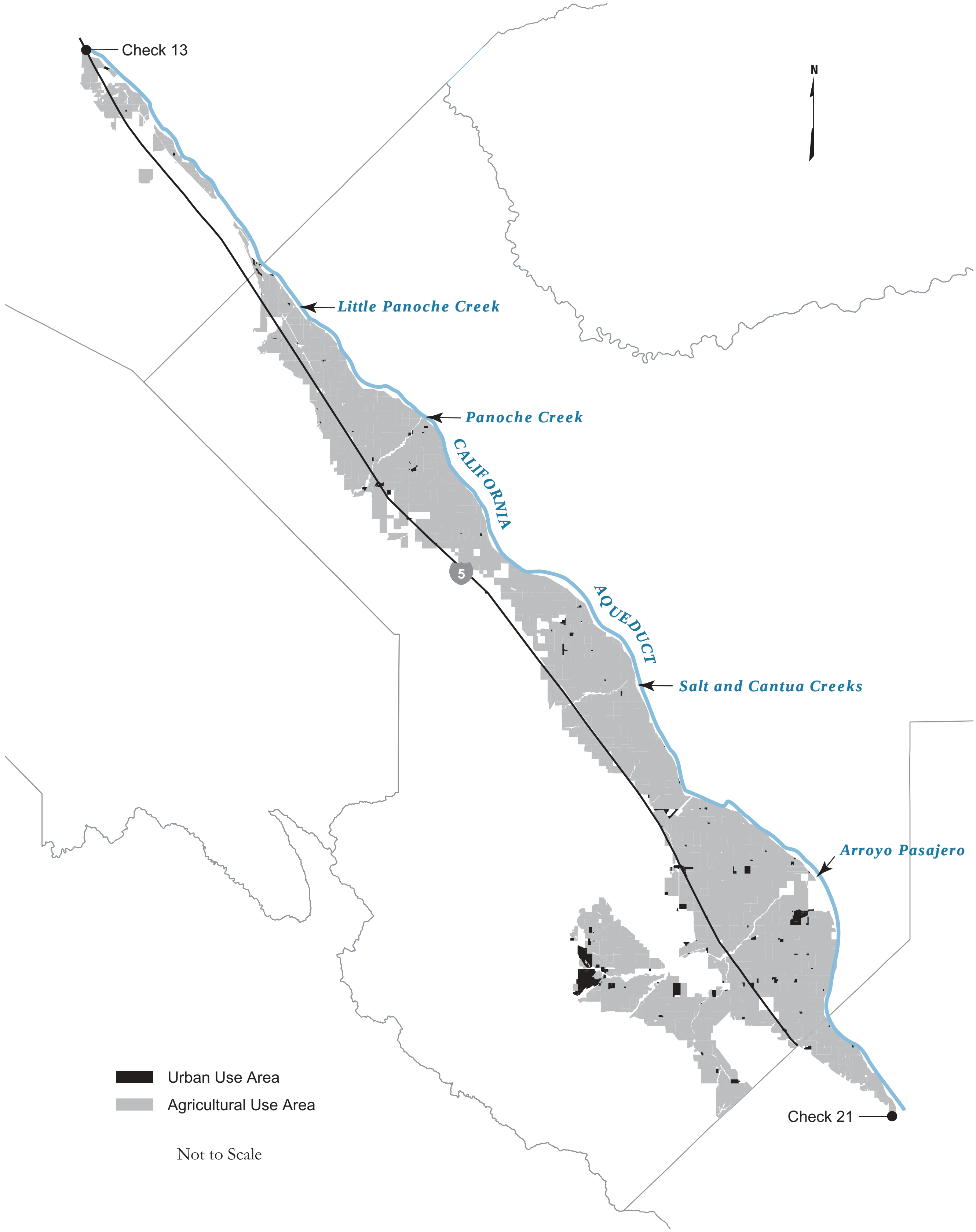
8.3.3.10 Unauthorized Activity

Only 1 survey has been done to detect unauthorized activity or illegal dumping. In Arroyo Pasajero, a ground survey was done to identify any potential hazardous, toxic, or radiological materials within the study area (DWR 1999). The study area included the proposed ponding basin against the aqueduct and, upstream, where the Gap Dam was proposed at the confluence of Los Gatos and Warthan creeks. These 2 areas represent a very small fraction of the entire watershed. The survey identified numerous tanks and drums, either in use or discarded. Some of the discarded drums were empty, and some exhibited visible leakage, usually petroleum products. A number of trash pits were also observed to contain a variety of nonhazardous items such as construction debris (concrete and wood), tires, and scrap metal. However, these appear to pose only a minor threat to water quality.

8.3.3.11 Transportation Corridors

During 1996 to 1999, a total of 29 vehicles were recovered from the SLC. Among these were 2 tractor-trailer rigs that released several gallons of oil to the SLC. On both occasions, absorbent booms were placed downstream to remove insoluble oil products. The more soluble products like benzene and toluene could get past the booms but would quickly volatilize downstream. Other potential threats from transportation corridors were addressed in *Sanitary Survey 1990* and appear to pose a minor threat to water quality.

Figure 8-15 Agricultural and Urban Use Areas West of the San Luis Canal



8.3.3.12 Accidents and Spills

There have been several incidents where contaminants were released into the aqueduct. The 1st was a small amount of hydraulic oil that leaked from a blown hydraulic line at Dos Amigos Pumping Plant. The 2nd incident involved a substance that was found floating on the surface of the aqueduct. The substance was identified as sulfur dust; probably overspray from aerial applications made to adjacent orchards. The 3rd incident was a sewage spill at the Kettleman City Water Treatment Plant. The sewage spill was contained by an earthen berm constructed next to the aqueduct. This potential source is considered a minor threat to water quality.

8.3.3.13 Groundwater Discharges

Groundwater discharges to the SLC can come from water service turnouts. There are 106 of these turnouts that can pump in groundwater from east-side agricultural lands (see Table 8-10). Pump-ins assisted State and federal water contractors during periods of entitlement deficiency caused, in part, by the 1987 to 1992 drought. Groundwater is pumped into the aqueduct in return for an equal amount of SWP water returned at another time and a place other than the original pump-in. Pump-ins mitigate for supply deficiencies imposed on federal water contractors. The pump-in program ended in 1996, when a very small amount of water (121 af) was admitted to the SLC. A new agreement is being developed to allow pump-ins in the event of future drought conditions.

A water quality study suggested that pump-ins can increase SLC salinity (DWR 1994). SLC pump-ins are typically elevated in TDS with levels ranging largely between 500 mg/L and 1,500 mg/L. At times, pump-ins comprise as much as 46% of Check 21 outflow. During these periods, TDS in the aqueduct increased. Pump-ins can also increase arsenic levels in the aqueduct.

Arsenic in SLC pump-ins ranges from <0.002 to 0.032 mg/L. Approximately two-thirds of the samples collected had arsenic levels below 0.005 mg/L. Regardless, the study indicated that high pump-in volumes had resulted in a net increase in aqueduct arsenic of about 0.001 mg/L. Levels in the aqueduct typically range between 0.001 and 0.003 mg/L. With the current MCL of 0.05 mg/L, this increase would not be significant.

Groundwater can also be pumped into the SLC via DWR sump pumps. These are automated groundwater pumps that relieve groundwater pressure on the upslope, or west side, of the canal liner. In some areas of the SLC, perched groundwater, if allowed to build up, can cave-in cement liners. These are typically where the canal right of way extends off the valley floor and up into the foothill zone. No information was available regarding the volume or quality of these inflows.

Gas, Oil, Geothermal Wells

There are several PCSs in this category that can affect ground water quality.

There are several thousand petroleum extraction wells in the San Joaquin Valley; an unknown number are west of the SLC. A land-use survey done in the mid-1990s counted 6 oil wells in 2 small areas within the Arroyo Pasajero watershed (USACE 1999). The survey was for the proposed Gap Dam site and not the entire watershed. The largest water quality threat from well activities is the marine-like water that is brought up along with the oil.

Nonhazardous brine water with salinity as high as 10,000 mg/L TDS can be co-extracted with crude oil. Oil companies deal with this water in several ways. Some send the mixture to tanks to separate out the oil. Brine water can also be sent to unlined excavations, or sumps, for evaporation and/or infiltration. Sumps vary in size, but most are about 50 by 20 feet. Brine water can also be reinjected into marine formations or recycled. There are other nonhazardous wastes generated from oil extraction, and they are handled using a variety of techniques:

- Mud pits are used to dispose of drill mud and cuttings in accordance with regulations contained in Title 27.
- Operational sumps are used in conjunction with drilling rigs when wells are newly drilled or reworked.
- Emergency overflow containment basins or catch basins are used where there is a potential for unplanned overflow of either brine water or oil. They also serve to prevent channel washouts during storms. Although these basins can be lined, oil companies can use them for emergencies only and must immediately remove any discharged oil by following a Spill Prevention, Control, and Countermeasure Plan.
- Pigging sumps consist of small trenches or poorly defined topographic low areas that receive waste fluid generated from internal cleaning of wastewater pipes. The pigging process can be performed, on average, every 3 years using fresh water.

Permitting of the brine water ponds began in the 1950s. In the 1970s, additional permits were issued for the ponds but tapered off because of changing priorities and limited staff. CVRWQCB considers oil field activities west of the SLC less of a priority because there are few nearby water bodies (ground or surface) with any beneficial uses. The Fresno office has recently received new positions dedicated to addressing oil well issues. Staff is needed because most oil field disposal methods do not meet current regulatory standards.

California is 1 of a few states where brine disposal sumps still exist. The California Water Code stipulates that any discharge to land has to meet certain conditions. Compliance may include liner construction coupled with groundwater monitoring. The CVRWQCB's current effort focuses on bringing brine dischargers into compliance with regulations by eliminating sumps and requiring other methods of disposal such as groundwater reinjection or recycling.

Although oil extraction wells exist in Arroyo Pasajero, no permits for brine water sumps were found in the CVRWQCB's files. Several larger, permitted sumps are farther south, beyond the SLC. Therefore, brine sumps do pose a water quality threat, but whether they exist west of the SLC remains unclear.

Oil Pipeline Break

In March 1995, floodwater in Arroyo Pasajero ruptured a live oil pipeline, releasing 4,400 barrels of oil 4 miles upstream from the aqueduct. Although the ponding basin held much of the oil-water mixture, a breach in the aqueduct levee occurred on the same day, releasing about 5,000 af of this water into the SLC. Water quality monitoring showed that some oil entered the aqueduct (DWR 1996).

Above-ground Petroleum Tanks

In Arroyo Pasajero, a ground survey was undertaken to identify any potential hazardous, toxic, and radiological materials within the study area. The study area included the proposed ponding basin against the SLC and upstream, where the Gap Dam was proposed at the confluence of Los Gatos and Warthan creeks. These 2 areas represent a very small fraction of the total watershed. Several above-ground storage tanks were identified in this survey. Sizes ranged from 500 to 10,000 gallons and usually contained gas or diesel.

On the SLC there are several turnouts with lubricated oil pumps sitting on top of the aqueduct levee. Some of these pumps are equipped with oil containers used to automatically lubricate the pumps. There are 5 such oil containers between mile 72 and 82, and 12 oil containers between mile 102 and 128. They range in size from 1 gallon to 55 gallons. In 1998, the USBR required Westlands Water District to install secondary containment structures for the tanks to capture any leakage, but only 2 of the containers are equipped with these containment devices. There is still a potential threat that leaks could enter the aqueduct, but these tanks and the previous PCSs appear to pose only a minor threat to water quality.

8.3.3.14 Geologic Hazards

Geology of the Diablo Range is dominated by marine sandstone such as continental and ancient ocean deposits, up to 1,000 feet thick in some places (Davis and others 1959). These deposits can contain concentrated salts such as sulfate, chloride, and magnesium. Sulfate originates from both marine and continental deposits. High chloride can also originate from the Panoche Formation that dominates the Salt (Merced County) and Little Panoche Creek watersheds. Serpentinite outcrops produce magnesium bicarbonate water that is unique to Arroyo Pasajero and Cantua Creek.

Highly saline springs exist in some of the SLC watersheds. The high salinity can originate from contact with ancient ocean deposits. As groundwater moves through these deposits, it dissolves the salts and transports them downstream. Other springs originate as ancient seawater trapped between sedimentary deposits (Davis 1961). These waters are called connate and are characterized as dilute seawater. Springs of this nature are known or suspected within the watersheds of both Salt creeks (Fresno and Merced counties), Panoche, Billie Wright, and Little Panoche creeks, Arroyo Ciervo, and Etoheverry (DWR 1995).

Serpentinite outcroppings are a source of asbestos in runoff and have been identified specifically in the headwaters of Arroyo Pasajero. The New Idria serpentinite body covers 48 square miles along the central part of the Diablo Range in Fresno County and eastern San Benito County. Serpentinite or other ultramafic intrusives comprise 13% of the Los Gatos Creek watershed, a tributary of Arroyo Pasajero (Davis 1961). Cantua Creek is also a source of asbestos, with 6% of the watershed containing exposed serpentine outcroppings. Asbestos-containing outcrops probably exist in other Diablo Range watersheds based on waterborne asbestos samples.

Diablo Range is the largest source of selenium in the San Joaquin Valley (Tidbal and others 1986). Selenium originates from marine sedimentary deposits defined as the Moreno and Kreyenhagen formations. These formations are intermixed with others of low selenium content in most of the Diablo Range watersheds but dominate the Monocline Ridge area (Gillium and others 1989). Runoff from this watershed contains elevated selenium relative to the other SLC watersheds (discussed in Section 8.3.4, Water Quality Summary). Most of the other watersheds west of the SLC contain a diverse mixture of sediment types with lower selenium levels.

Since these contaminants would only reach the SLC via floodwater inflows, they are included with the assessment of that PCS in Section 8.3.3.1.

8.3.3.15 Population and General Urban Area Increase

Approximately 3% of the farmable land is urbanized, not counting roads (see breakdown in Section 8.3.3.7, Agricultural Activities, under Potential Contaminant Sources). However, this represents only a small fraction of the total acreage west of the SLC. Therefore, urban areas make up a very small portion of the total watershed.

8.3.4 WATER QUALITY SUMMARY

8.3.4.1 Diablo Range Watersheds

From 1996 to 1999, floodwater inflows to the SLC totaled 23,787 af, with the majority occurring in 1998 (Table 8-15). During that year, 86% of all inflows occurred in February. The major contributors were Cantua Creek with 31% of the February total followed by Little Panoche Creek (25%) and Arroyo Pasajero (12%) (Figure 8-16). In addition to inflows from the Diablo Range, water from the Kings River (7,236 af) was admitted to the aqueduct via Lateral 7 (mile 115.40) April through June 1998 (Figure 8-16). The water originated from the Mendota Pool and was composed largely of releases for flood control from Sierra Nevada reservoirs (DWR 2000). There were no inflows, floodwater or otherwise in 1999.

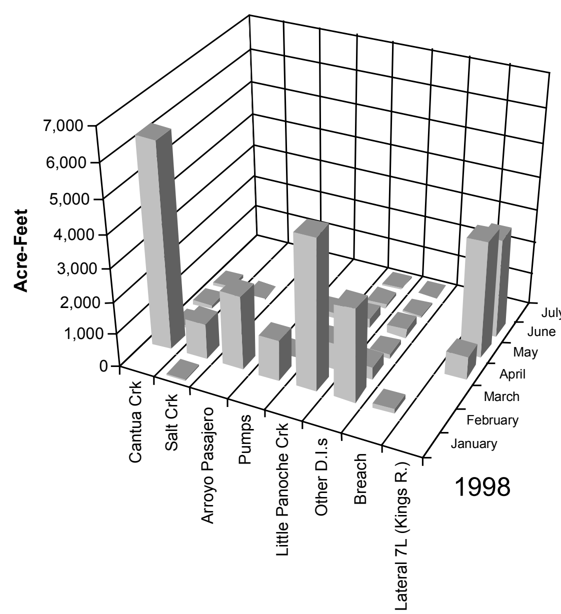
Federal contractors usually take water from the SLC during the winter for preirrigation. This sometimes has the unintentional benefit of diverting floodwater out of the aqueduct. For instance, during February 1998, about half of all SWP/non-SWP inflow to the canal was diverted for preirrigation. This means that some of the February floodwater inflow, mixed with SWP water from the Delta, was diverted from turnouts located throughout the SLC. Although these diversions would tend to minimize water quality impacts in the aqueduct, downstream conductivity increased by 50 µS/cm to 400 µS/cm (approximately equal to 30-230 mg/l calculated TDS) for more than a month.

TDS in floodwater during 1996 to 1999 ranged from a low of 89 mg/L in Skunk Hollow to a high value of 2,890 mg/L in Salt Creek (Table 8-16). Historically, median TDS has ranged between 705 mg/L and 897 mg/L (Figure 8-17). TDS levels as high as 4,310 mg/L have been measured in the past, but most extreme values were from smaller drains grouped in the "All others" category in Figure 8-17. Individually, these sources comprise a small portion of the total volume. Some of the highest TDS levels were from watersheds like Monocline Ridge where no drain inlet structures exist and floodwater is pumped into the SLC by portable pumps (DWR 1995). Regardless, TDS levels in floodwater are higher than those in the aqueduct and have been shown to affect in-stream concentrations (DWR 2000).

Table 8-15 Sources of Annual SLC Floodwater Inflows, 1996 to 1999

Source	1996	1997	1998	1999
Cantua Creek	288	1,369	6,506	0
Salt Creek	51	305	1,162	0
Arroyo Pasajero	0	0	2,278	0
Little Panoche Cr.	0	203	6,092	0
Pumps	0	199	1,446	0
Other DIs	2	60	3,694	0
Breaches	0	0	132	0
Total Inflows	341	2,136	21,310	0

Figure 8-16 Monthly Floodwater Inflows, 1998



From 1996 to 1999, TSS in floodwater inflows ranged from 14 to 12,500 mg/L (Table 8-16). The high value from Little Panoche Creek approached the historical maximum of 13,000 mg/L in Salt Creek (Figure 8-17). This is consistent with field staff observations that sometimes have compared floodwater to "chocolate milk." Suspended solids were lowest in Arroyo Pasajero with a 1998 concentration of 14 mg/L and a historical range of between 14 and 77 mg/L. The low levels there are attributable to ponding against the aqueduct and a decantation weir. The weir, installed in 1985, was designed to reduce sediment inputs into the aqueduct.

Inflow from the Jordan Group and Salt Creek exhibited nearly identical mineralogy in January 1998. Although a distance of 2 miles separates these drain inlets, runoff from both watersheds can apparently commingle prior to reaching the aqueduct, and historical data supports this. Conversely, mixing of Cantua and Salt creeks appears to be uncommon. Samples collected on the same day at Salt and Cantua creeks rarely exhibited similar mineralogy. A little more than 1 mile separates these 2 inlets. In late 1999, a new drain inlet was installed that combines floodwater from both watersheds.

Little Panoche Creek had higher chloride and sulfate concentrations than other floodwater sources to the aqueduct. This is an indication of upstream springs composed of connate water. Connate water is ancient seawater trapped between sedimentary deposits. Although most floodwater is high in salts, it does not usually exhibit these characteristics. Water reflecting the mineralogy of seawater would also contain other ocean-related parameters such as bromide. This was supported with a limited bromide database.

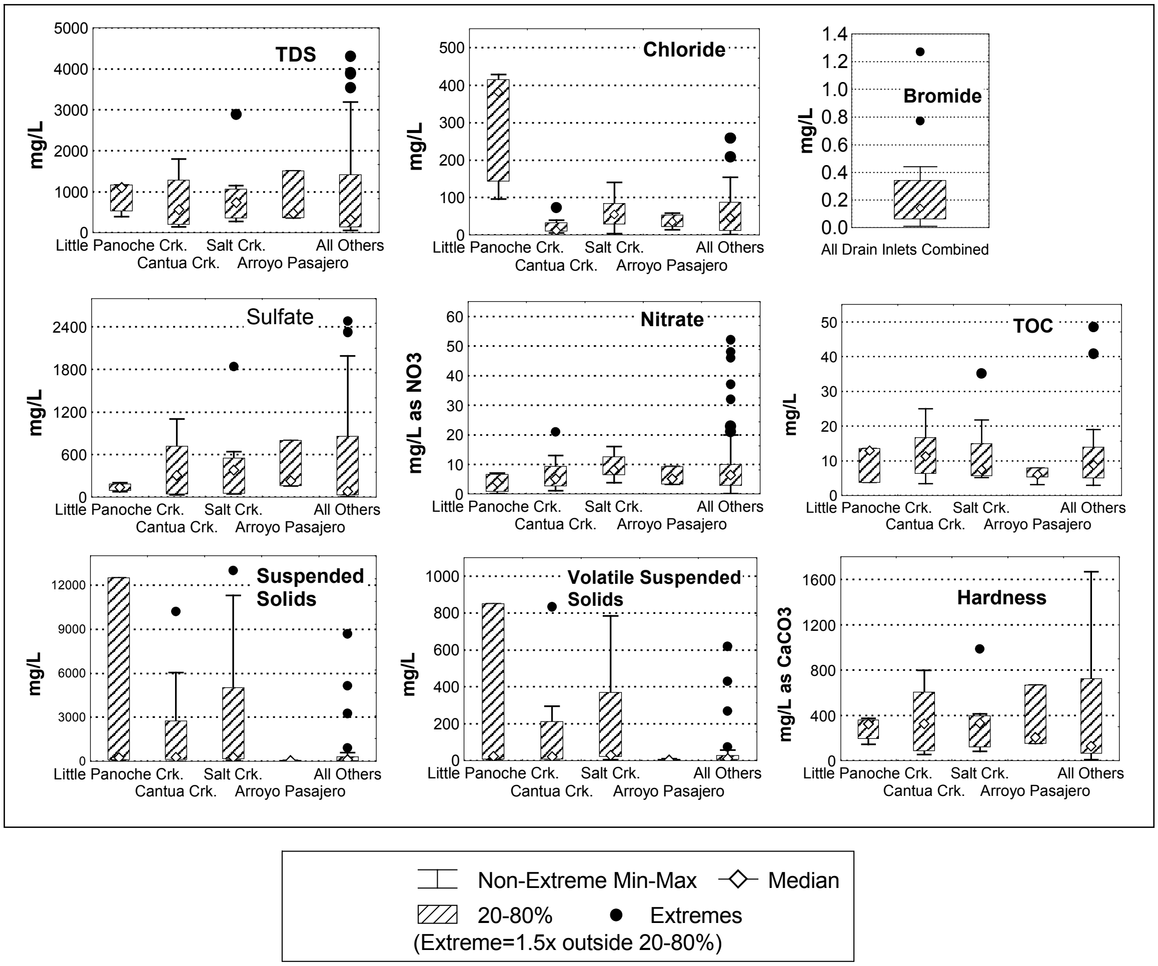
Bromide is not monitored routinely in floodwater, so no data exist for 1996 to 1999. Bromide in 15 historical floodwater samples ranged from 0.01 to 1.27 mg/L (Figure 8-17). The high value of 1.27 mg/L was measured in Little Panoche Creek. Another high value of 0.77 mg/L was measured in floodwater from Monocline Ridge (mile 113 to 119). Water from this area must be pumped in, and as a result, inflow volumes from this area tend to be relatively minor. One sample each from Arroyo Pasajero and Cantua and Salt creeks had relatively low concentrations of 0.03, 0.16, and 0.06 mg/L, respectively. Therefore, bromide was not consistently elevated in the few samples collected. However, the paucity of data precludes any final determination of whether floodwater is a major source of bromide to the aqueduct.

Table 8-16 General Water Quality Parameters in San Luis Canal Floodwater Inflows[a]

			Conventional Parameters									Cations				Anions			Other	
Watershed	Milepost	Sample Date	pH	Organic Carbon (Tot.)	Turbidity, NTU	Susp. Solids (Tot.)	Susp. Solids (Vol.)	TDS	Conductivity, µS/cm	Hardness (CaCO3)	Bicarbonate (CaCO3)	Calcium	Magnesium	Sodium	Potassium	Sulfate	Chloride	Nitrate (NO3)	Fluoride	Boron
Ortigalita Creek	82.67	1/27/1997	8.3	14	480	596	56	606	1000	209	194	41	26	126	NA	155	96	3.7	0.3	1.3
	82.67	2/3/1998	8.1	48.6	6,120	8,680	620	313	523	115	97	23.0	14.0	62.0	NA	95	38	5.2	0.3	0.50
Little Panoche Crk.	96.56	1/25/1997	8.3	NA	50	NA	NA	1100	1920	349	246	74	40	260	NA	132	381	1.6	0.5	7.1
	96.59	2/3/1998	8.1	13.0	9,920	12,500	850	391	681	144	100	38.8	11.4	79.8	NA	76	96	3.9	0.3	1.99
Monocline Ridge	115.43	3/3/1996	7.1	5	NA	31	4	232	394	95	55	20	11	39	NA	52	44	5.0	<0.1	0.3
Lateral 7L (Kings R.)	115.43	4/27/1998	7.4	NA	32	NA	NA	106	169	43	40	10.5	4.1	13.8	NA	19	13	1.0	<0.1	<0.10
	115.43	5/19/1998	7.9	NA	16	NA	NA	146	266	64	58	13.7	7.2	28.4	NA	25	32	0.5	<0.1	0.12
Cantua Creek	134.81	2/5/1996	8.7	7	NA	593	55	509	792	341	246	31	64	49	4.3	170	10	1.1	0.1	0.3
	134.81	1/3/1997	8.5	5	NA	106	7	372	629	263	207	26	48	31	3.3	109	6	1.2	0.1	0.3
Salt Creek	135.96	4/7/1998	NA	5.3	152	NA	NA	391	NA	130	NA	27.3	14.9	54.6	NA	83	57	5.6	0.1	0.37
	136.00	2/1/1996	7.9	14	NA	121	11	2890	3560	985	98	236	96	520	9.8	1840	140	12	0.5	2.1
	136.00	1/3/1997	7.8	22	NA	472	35	1150	1600	393	88	90	41	198	4.9	638	44	3.8	0.5	0.9
	136.00	1/13/1998	8.0	5.7	NA	169	24	310	539	116	80	27.5	11.6	62.4	NA	46	84	8.0	<0.1	0.18
Jordan Group	138.14	1/20/1998	8.0	7.5	101	132	10	323	576	128	81	26.7	15.0	62.0	NA	56	84	6.7	<0.1	0.22
	138.96	1/16/1997	7.0	4	42	15	1	242	412	100	32	30	6	38	NA	118	17	5.0	0.2	0.4
Skunk Hollow	146.44	2/17/1998	7.6	4.3	267	163	14	89	161	45	35	11.8	3.7	10.1	NA	9	5	22.7	0.2	<0.10
Arroyo Pasajero	158.38	2/8/1998	8.0	5.8	12	14	2	585	886	244	122	49.2	29.3	94.3	NA	283	22	3.7	0.3	0.51

[a] Units are mg/L unless otherwise noted.

Figure 8-17 Historical Water Quality of SLC Floodwater Inflows



Similar to bromide, TOC data for floodwater are not extensive. Median TOC levels in floodwater ranged between 7 and 12 mg/L (Figure 8-17). A very high value of 49 mg/L was reported for Ortigalita Creek in 1998 (Table 8-16), the highest ever recorded in floodwater. This sample was collected on the 1st day of inflow and likely captured the peak of a 1st flush effect. Concentrations can peak in the early stages of a runoff event and then taper off as less TOC is available to be flushed from a watershed (this can also occur with a number of other parameters). Inflows from Ortigalita Creek have historically been minor, but almost 2,000 af flowed into the SLC during 1998 when the high level was measured. TOC was lowest in Arroyo Pasajero and ranged from 3 to 8 mg/L in 7 historical samples. TOC ranged from 3.5 to 25 mg/L in Cantua Creek and from 5.2 to 35 mg/L in Salt Creek. Little Panoche Creek exhibited TOC levels of 13 and 13.9 mg/L in 2 samples.

Unlike the major minerals and other parameters of concern, minor elements are not typically elevated in floodwater inflows. From 1996 to 1999, arsenic levels ranged from 0.001 mg/L to 0.003 mg/L (Table 8-17). The highest arsenic level ever recorded in floodwater was 14 µg/L (DWR 1995). The database on arsenic is limited because the reporting limit was 10 µg/L up until 1986. Selenium in floodwater ranged from below detection to 16 µg/L (Salt Creek) from 1996 to 1999. For most drain inlets, selenium was below detection.

The common earth metals iron and manganese were detected at relatively low levels from 1996 to 1999 and never exceeded 0.051 mg/L (Table 8-17). Historically, higher levels have been detected in some of the smaller watersheds, but the cause of the high levels was never determined (DWR 1995). Aluminum was never detected above the reporting limit from 1996 to 1999.

Table 8-17 Water Quality of Minor Elements in San Luis Canal Floodwater Inflow (Concentration in mg/L)

	Watershed															
	Ortigalita Creek		Little Panoche Creek		Lateral 7L (Kings R.)		Monocline Ridge Grp.	Cantua Creek		Salt Creek			Jordan Group		Skunk Hollow	Arroyo Pasajero
Milepost	82.67	82.67	95.56	96.59	115.43	115.43	115.81	134.81	134.81	136.00	136.00	136.00	138.14	138.96	146.44	158.38
Sample Date	27 Jan 1997	3 Feb 1998	25 Jan 1997	3 Feb 1998	27 Apr 1998	19 May 1998	3 Mar 1996	5 Feb 1996	3 Jan 1997	1 Feb 1996	3 Jan 1997	13 Jan 1998	20 Jan 1998	16 Jan 1997	17 Feb 1998	8 Feb 1998
Aluminum	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Arsenic	0.003	0.002	0.002	0.003	0.001	0.001	0.001	0.003	0.002	0.002	0.001	0.002	0.002	0.003	0.004	0.001
Barium	0.056	<0.050	0.116	0.070	<0.050	<0.050	<0.050	<0.050	<0.050	0.128	0.101	0.093	0.052	0.055	<0.050	<0.050
Cadmium	<0.005	<0.001	<0.005	<0.001	<0.001	<0.001	<0.005	<0.005	<0.005	<0.005	<0.005	<0.001	<0.001	<0.005	<0.001	<0.001
Chromium	<0.005	<0.005	<0.005	0.006	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Copper	<0.005	0.003	<0.005	0.003	0.002	0.002	<0.005	0.005	<0.005	<0.005	<0.005	0.005	0.003	<0.005	0.002	0.004
Iron	0.034	0.009	<0.005	0.012	<0.005	0.009	0.041	<0.005	<0.005	0.007	0.006	0.020	0.030	0.006	<0.005	<0.005
Lead	<0.005	<0.001	<0.005	<0.001	<0.001	<0.001	<0.005	<0.005	<0.005	<0.005	<0.005	<0.001	<0.001	<0.005	<0.001	<0.001
Manganese	0.034	0.024	0.009	0.008	<0.005	<0.005	0.008	0.008	<0.005	0.010	0.007	0.010	0.051	<0.005	0.018	0.007
Mercury	<0.001	<0.0002	<0.001	<0.0002	<0.0002	<0.0002	<0.001	<0.001	<0.001	<0.001	<0.001	<0.0002	<0.0002	<0.001	<0.0002	<0.0002
Selenium	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.004	0.003	0.016	0.007	<0.001	<0.001	0.002	<0.001	0.003
Silver	<0.005	<0.001	<0.005	<0.001	<0.001	<0.001	<0.005	<0.005	<0.005	<0.005	<0.005	<0.001	<0.001	<0.005	<0.001	<0.001
Zinc	<0.005	<0.005	<0.005	<0.005	0.006	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.050	<0.005	<0.005	<0.005

Organic chemicals, more specifically insecticides and herbicides, are routinely detected in floodwater inflows. The most frequently detected compounds from 1996 to 1999 were cyanazine, dacthal, simazine, diazinon, methadathion, trifluralin, oxyfluorfen, and diuron (Table 8-18). Cyanazine, diuron, and dacthal are preemergence and early postemergence herbicides (WSSA 1983). During the winter, applications are likely made to land west of the SLC in preparation for planting or general weed control. They are carried into the SLC when applications are followed by rainfall events.

The insecticide diazinon, and possibly simazine, is applied to stone fruit and nut orchards (almond, apricot, peach) to prevent flower bud predation by insects. Not as extensive as ground crops, orchards make up about 7% of the irrigated land west of the SLC. Applications are made in winter before trees blossom, the same period when floodwater inflows are highest. The window of application is between December and April. The offside migration of these pesticides from stone fruit orchards occurs around the Central Valley.

Most pesticides in floodwater are at or below 1 µg/L, and therefore, would have probably been diluted to below detection in the SLC. Two exceptions to these low levels occurred in 1998: Both cyanazine and dacthal were detected in a drain inlet from the Jordan Group at around 40 µg/L. These detections were made when inflow measured 7 af, thus, the pesticides would have been heavily diluted in the SLC. Another high detection occurred the same year in Salt Creek–cyanazine at 22 µg/L. Studies have shown that most pesticides are conveyed into the aqueduct via south Delta exports (DWR 1995).

Table 8-18 Water Quality of Organic Chemicals in San Luis Canal Floodwater Inflows (Concentration in µg/L)

	Watershed												
	Ortigalita Creek		Little Panoche Creek	Monocline Ridge Group	Cantua Creek		Salt Creek			Jordan Group		Skunk Hollow	Jordan Group
Milepost	82.67	82.67	96.59	115.43	134.81	134.81	136.00	136.00	136.00	138.96	138.96	146.44	158.38
Sample Date	1/27/1997	2/3/1998	2/3/1998	3/3/1996	2/5/1996	1/3/1997	2/1/1996	1/3/1997	1/13/1998	1/16/1997	1/20/1998	2/17/1998	2/8/1998
Chlorinated Pesticides	ND	ND	ND					ND				ND	ND
Simazine				0.40	<0.02	<0.02	0.03		0.14	0.60	0.11		
Diuron				3.47	<0.05	0.40	0.16			0.24			
Dacthal (DCPA)				0.08	0.03	<0.01	1.27			41			
Oxyfluorfen				<0.02	<0.02	0.07	<0.02			1.16			
Nitrogen/ Phosphorus Pesticides	ND	ND	ND								ND		ND
Cyanazine				0.16	0.15	0.47	0.92	1.02	22.10	40		0.39	
Diazinon				0.04	0.03	<0.01	0.09	<0.01					
Methidathion				<0.02	<0.02	<0.02	0.03	<0.02					
Trifluralin				<0.05	<0.05	<0.05	<0.05	0.12					
Chlorinated Phenoxy Acid Herbicides	ND	ND	ND		ND	ND	ND	ND	ND	ND	ND	ND	ND
Chlorinated Pesticides	ND	ND	ND						ND	ND	ND	ND	ND
2,4,-D				0.06	<0.10	<0.10	<0.10	<0.10					
Purgeable Aromatics	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Glyphosate	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbomate Pesticides	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Volatile Organics	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

ND = None Detected

Data on asbestos in floodwater are limited because of cutbacks in asbestos monitoring during the 1990s. Existing data show asbestos is not consistently detected in floodwater, although high turbidities are partially responsible for many of the below-detection values. Asbestos ranged from <5.3 million fibers per liter or MFL (only fibers greater than 10 microns) to a high of 1,900 MFL in Salt Creek (Table 8-19). Asbestos analysis is hindered by high TSS levels typically present in floodwater inflows. Suspended solids are trapped along with asbestos during filtration and physically occlude individual fibers from being counted resulting in below detection results accompanied by unusually high detection limits.

8.3.4.2 Water Supply System

A complete 1996 to 1999 water quality assessment has already been performed for Check 13 and Check 21 (DWR 1999b and 2000). Below is a review of selected drinking water parameters for these stations along with any violations of the primary or secondary MCLs. Check 13 is technically identified as Dos Amigos Pumping Plant because flow is controlled there and not at the outlet of O'Neill Forebay. For the purposes of this discussion, Check 13 will refer to the forebay's outlet.

Check 13 (O'Neill Outlet)

Check 13 reflects the water quality of all inputs from O'Neill Forebay including inflows from the San Luis Reservoir, California Aqueduct at Check 12, and DMC.

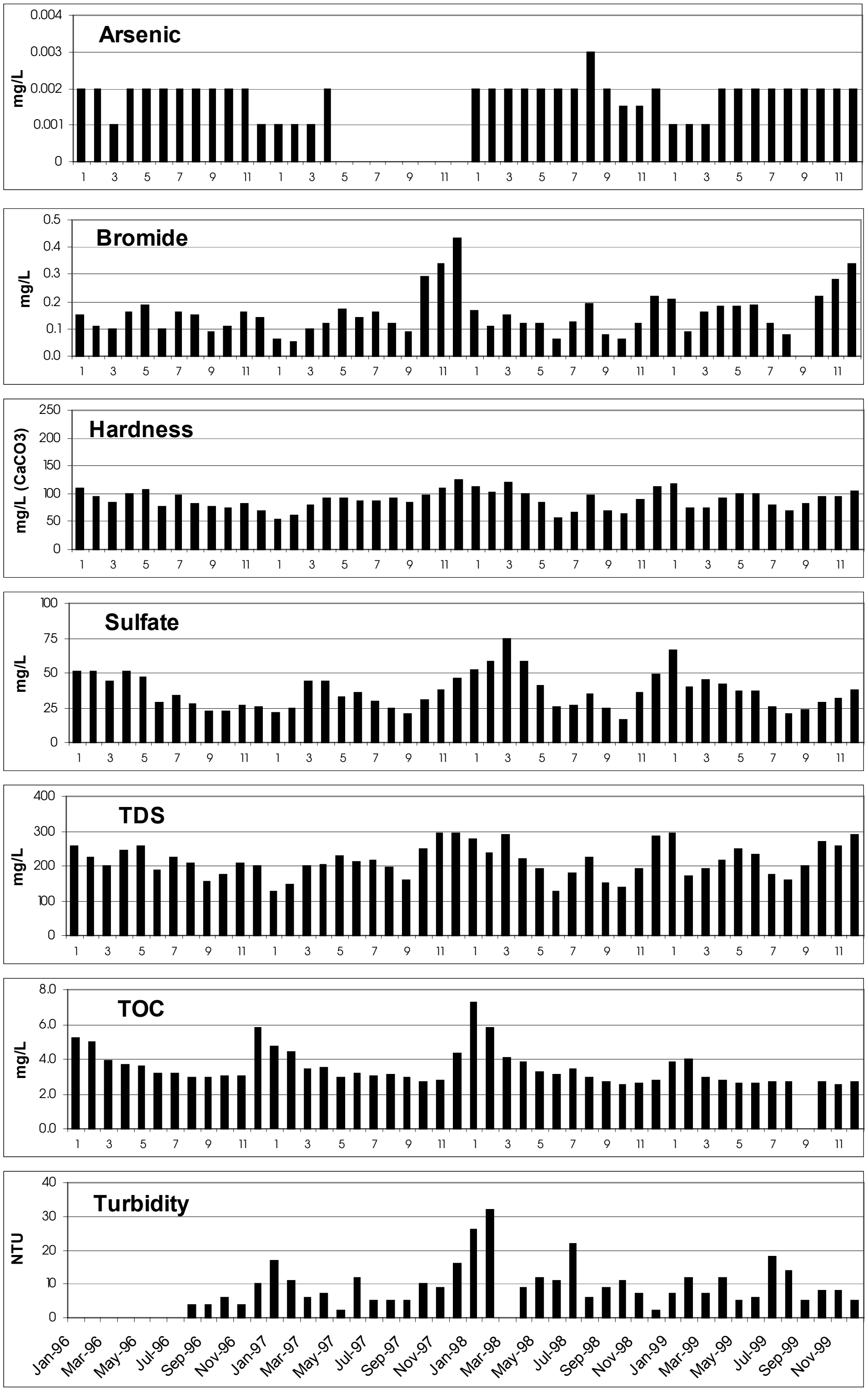
Arsenic ranged largely between 0.001 and 0.002 mg/L during the 1996 to 1999 period with 1 value reaching 0.003 mg/L (Figure 8-18). Bromide ranged largely below 0.2 mg/L with peaks of 0.43 mg/L and 0.34 mg/L during December of both 1997 and 1999, respectively. Hardness at Check 13 ranged from 54 to 125 mg/L and sulfate ranged from 16 to 74 mg/L. Peaks of these 2 compounds were much higher at Check 21 due to floodwater inflows. TOC exceeded 4 mg/L on several occasions, largely around January of 1996, 1997, and 1998. The TOC peak of 7.3 mg/L was detected in January 1998 when inflows to O'Neill Forebay were largely from San Luis Reservoir releases and the DMC. All organic chemicals (such as pesticides), metals, and nutrients were below any respective primary or secondary MCLs.

Table 8-19 Asbestos in San Luis Canal Floodwater Inflows

Watershed				
ID #	Name	Sample Date	Concentration MFL[a]	Detection Limit
28	Cantua Creek Group	4 Mar 1991	ND	11
		4 Mar 1991[b]	ND	5.3
		16 Jan 1993	950	320
		19 Feb 1993	380	380
29	Salt Creek Group	4 Mar 1991	ND	110
		16 Jan 1993	ND	1,300
		19 Feb 1993	1,900	480
	Milepost 137.80[b]	20 Mar 1991	ND	210
		20 Mar 1991[c]	ND	210
33	Arroyo Pasajero[d]	20 Mar 1991	ND	210
		20 Mar 1991[c]	ND	210
		17 Mar 1993	ND	64
		10 Mar 1995	83	23
		10 Mar 1995	166	45
		10 Mar 1995	416	113
		23 Mar 1995	17	5
		23 Mar 1995	42	11

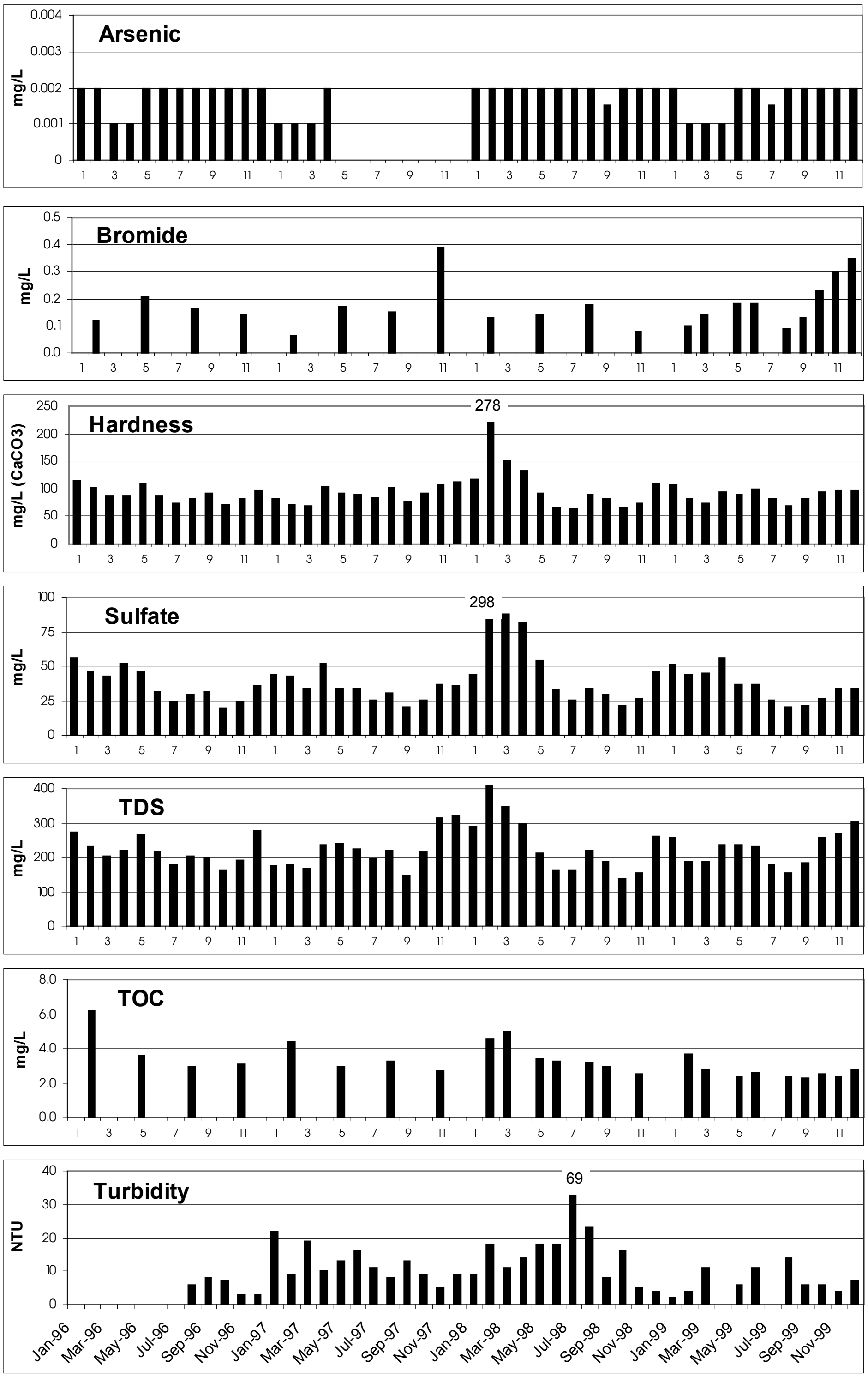
[a] Million fibers per liter of fibers >10 microns in length. ND = Not Detected
[b] Replicate [c] Pump-in from portable pump at milepost 137.80
[d] Water sampled from the ponding area weir although none was admitted to the aqueduct.

Figure 8-18 Water Quality on the California Aqueduct, Check Check 13



Check 21 is at the end of the SLC and represents aqueduct water affected by Diablo Range floodwater inflows directly upstream. Arsenic at Check 21 remained at or below 0.002 mg/L during 1996 to 1999 (Figure 8-19). Bromide trends were similar to those at Check 13, with a peak of 0.39 mg/L in November 1997. In February 1998, TDS was 593 mg/L, above the recommended secondary MCL for finished drinking water of 500 mg/L. In the same sample, sulfate was above the secondary MCL of 250 mg/L. These high levels were caused by floodwater inflows from the Diablo Range. Although not as extensive as Check 13 data, quarterly TOC sampling detected peaks of 6.2 mg/L during February 1996 and up to 5 mg/L in February and March 1998. Turbidity reached 69 nephelometric turbidity units (NTUs) in July 1998 and probably reflects the resuspension of floodwater sediments deposited several months earlier. Sediments deposited during winter when aqueduct flow is low can be resuspended during the summer when higher flows from increased demand cause increased scour. All organic chemicals (such as pesticides), metals, and nutrients were below any respective primary or secondary MCLs.

Figure 8-19 Water Quality on the California Aqueduct, Check 21



8.3.5 SIGNIFICANCE OF POTENTIAL CONTAMINANT SOURCES

The significance of floodwater inflows in general is discussed followed by the significance of individual sources and specific watersheds or both.

8.3.5.1 Floodwater Inflows

The single most significant PCS along the SLC, floodwater inflows are significant contributors of salt and sediment. Insufficient data were available to determine the significance of other important drinking water parameters such as bromide and organic carbon. Although available data show these compounds can be elevated in some drain inlets, not enough data exist to determine whether floodwater overall is the major source to the SLC. Pathogen data are also limited, but suspended solids can sometimes be an indicator of pathogens.

Suspended solids in floodwater can be up to 4 orders of magnitude higher than aqueduct levels. Up to 80% of the monthly sediment load to the aqueduct can come from floodwater inflows (DWR 1995). Unlike salts, sediment can settle out in the aqueduct, only to be resuspended when flows increase as deliveries are made the following summer. Suspended sediments cause problems for drinking water contractors and are potential indicators of other constituents such as pathogens and asbestos.

High turbidities (a measure of suspended solids) in raw water require greater coagulant dosages to settle the particles. The resulting floc quickly clogs filters, necessitating more frequent backwashing to keep the filters in operation. More floc means more sludge production, increasing management costs. High turbidities also interfere with the disinfection process. Particulates adhering to the surface of a bacterium's cell can shield it from the oxidizing action of disinfecting agents, thereby reducing treatment efficiency and increasing dosages needed to assure complete sterilization. Other effects include the formation of chlorinated organic compounds. Problems caused by floodwater sediment were particularly evident in 1995.

In March 1995, floodwater inflow discharged tons of sediment to the SLC. Because the sediment was composed largely of clay and silt, it was easily suspended in the aqueduct. The Avenal Water Treatment Plant was forced to shut down and issue an immediate boil order. Because of severe sediment loading and filter clogging, the plant was producing potable water with turbidities ranging between 1 and 6 NTUs, well above the 0.5 standard. A stoppage occurred on March 10 because of a break in the main line and elevated turbidities. Raw water turbidities peaked at 2,900 NTUs on March 11, decreased to 500 NTUs on March 12 and to 45 NTUs on March 13. Until the time of the break, the plant was producing potable water, although with difficulty. The difficulty was attributed to filter clogging which, in turn, forced more frequent and lengthy backwashing. Six days after the stoppage, the treatment plant was brought back into service. The boil advisory lasted for a total of 15 days.

Sediment from the March 1995 floodwater migrated downstream and affected Southern California water treatment plants several months later. High turbidities were initially detected on the East Branch of the California Aqueduct in June. All 5 MWDSC treatment plants taking water from Silverwood Lake experienced high influent turbidities that lasted almost 3 months. One plant measured turbidities of around 28 NTUs for a short period of time and elevated levels above 10 NTUs for about 2 months. During this period, treatment plants experienced various operational difficulties. Chemical dosages of alum, ferric chloride, and polymer coagulation enhancers were increased to handle the higher particulate loads. The turbidity goal of 0.10 NTU in finished water was exceeded several times at 1 plant. This goal is more conservative than the State's enforced maximum of 0.5 NTU and was adopted by MWDSC as recommended by the American Water Works Association (AWWA), EPA, and DHS. Increased sludge production resulted in handling difficulties and excessive equipment wear. Potable water production was slowed to facilitate particulate removal. Influent turbidities began returning to normal in early September. The added operational costs from this event approached $500,000.

Water drawn from the West Branch of the California Aqueduct was not affected because sediment had an opportunity to settle out in Castaic and Pyramid lakes. The settling capacity of Silverwood Lake on the East Branch is not as great because of a shorter retention time.

The 1995 flood also affected groundwater recharge operations in Kern County. SWP water was rejected during the spring/summer because the small grain size of the suspended sediment could effectively seal off pore spaces in the basin soils, potentially lowering infiltration rates. Once pore spaces have been plugged, restoration of a basin can be a time-consuming and expensive process. When heavy machinery is used to scrape the surface, soils can become compacted, further reducing infiltration rates. Another restoration technique involves planting crops to "reopen" the soil matrix. However, this effectively removes the basin from service for an extended period of time.

Kern County Water Agency (KCWA) staff estimated that their plan to recharge 150,000 af to 200,000 af during the summer months of 1995 would have brought 80,500 cubic yards of sediment into the participating basins. Delivery of SWP water to Kern Water Bank, Pioneer, and the city of Bakersfield recharge properties was delayed until turbidities dropped to acceptable levels.

Therefore, suspended sediment in the form of turbidity from floodwater inflows is considered to be significant, not only from a human health standpoint, but also from a water treatment plant management standpoint. As such, several recommendations were made to address these inputs. Sediment from floodwater has caused more problems than from TDS, the other general constituent that is elevated in floodwater inflows.

Similar to TSS, TDS is also relatively high in floodwater. Monthly salt loads to the SLC were estimated to be as high as 6% (DWR 1995). Salinity in the aqueduct has become a major concern to SWP contractors in Southern California. Salinity problems were documented in a recent study (Bookman 1999):

- Calcium and magnesium (components of salinity) leave deposits in plumbing systems and reduce the effectiveness of laundry detergents.
- Plumbing and home appliances wear out faster.
- At sufficiently high levels, salt can impart an undesirable taste in potable water.
- Salinity levels increase with each cycle of urban use for residential, commercial, or industrial purposes. When levels become too high, recycled water cannot be used for groundwater recharge or crop irrigation.

The MWDSC initiated a blending program to manage these issues. SWP water from the East Branch is blended with higher salinity water from the Colorado River to achieve a TDS goal of 500 mg/L, the secondary State and federal drinking water standard. As a result, salinity in the aqueduct has become an important issue. The secondary blending option occurs from April through September when floodwater inflows are unlikely. However, unlike pathogens, salt standards in drinking water were developed to reduce taste and odor problems, not to protect human health. Therefore, salt in floodwater would not be considered as significant as other more problematic constituents like suspended solids.

8.3.5.2 Asbestos from Arroyo Pasajero

Studies have documented elevated levels of asbestos in Arroyo Pasajero (DWR 1990). Recent data show the threat to drinking water from this source may not be as great as originally thought, although it is still a concern.

Airborne asbestos is a known human health threat. If inhaled, it can cause lung tissue scars, hindering oxygen exchange with blood capillaries. Asbestos has also been associated with the incidence of certain types of lung cancer. Alternately, the health implications linking human-related ailments to waterborne asbestos are not as clearly understood. Regardless, concerns over any potential health risks led the EPA in 1992 to adopt a standard of 7.1 MFL (longer than 10 microns) as the MCL for asbestos in treated drinking water.

Long-fiber asbestos concentrations ranged from below detection to 416 MFL in samples collected from inside Arroyo Pasajero's decantation weir where discharges to the aqueduct are made (see Section 8.3.4, Water Quality Summary). Most of these samples were collected when there was no flow, that is, inflow gates were closed at the time of sampling. This would allow some of the asbestos to settle out and result in an underestimate. On the other hand, Arroyo Pasajero has the lowest turbidities of any other floodwater source and, presumably, lower asbestos levels. The supposition that low suspended solids equals low asbestos is due to asbestos being a component of suspended solids. Therefore, the decantation weir and ponding basin strategy have been successful at reducing suspended solids and, presumably, asbestos. Regardless of the relative concentrations, most asbestos in Arroyo Pasajero is of the short-fiber type (fibers less than 5 microns in length on average), and these are considered less of a human health threat than the longer type (USACE 1999). Further, asbestos levels in the decantation weir were not that much higher than those in the aqueduct.

At Banks Pumping Plant, asbestos fibers greater than 10 microns ranged from 0.7 to 83 MFL (median 14 MFL) with detection limits of 0.19 to 22 MFL. The presence of asbestos in the aqueduct indicates that Arroyo Pasajero, as well as all drain inlets, are contributing to levels already present and routinely above the MCL of 7.1 MFL for treated drinking water. This would tend to diminish the significance of Arroyo Pasajero with respect to asbestos. Regardless of whether or not Arroyo Pasajero is a major source of asbestos to the aqueduct, studies show that the conventional water treatment process removes most asbestos present in aqueduct water.

In 1986 a study was undertaken to determine how much asbestos is removed through the conventional water treatment process. Three MWDSC plants in Southern California averaged 99% removal of total asbestos with raw water levels as high as 500 MFL. One plant operated by KCWA removed 99.9% of the raw water asbestos at levels ranging from 1.2 to 1,400 MFL total asbestos. This study would indicate asbestos inputs from Arroyo Pasajero, or possibly all floodwater sources, would not be as big a water quality threat as once thought. However, it is still considered a significant potential threat.

8.3.5.3 Other Sources

Most of the specific PCSs listed above were not considered significant. This includes, but is not limited to, most of the permitted facilities, urban runoff, toe drains, and unauthorized activity. The overwhelmingly large floodwater volumes generated west of the SLC would likely dilute any single source releasing a particular contaminant. Further, natural sources of potential contaminants such as TOC and pathogens can be inherently elevated in floodwater and would probably overshadow any input from 1 or several sources. In other words, it would be difficult to document whether a facility or activity in the watershed resulted in an increase in potential contaminants in floodwater admitted to the aqueduct. The exceptions, of course, are activities like pesticide applications or vehicles in the aqueduct. However, their significance was identified as minor. The other exceptions are confined animal facilities and pump-ins.

Both Harris Ranch (cattle) and Thommen Dairy are particularly significant PCSs. If the holding ponds that collect yard runoff failed, wastewater with very high pathogen levels could be released off-site. This water could pond against the aqueduct in the case of Harris Ranch or flow into the aqueduct in the case of Thommen Dairy. According to the CVRWQCB, breaches or releases from confined animal facility holding ponds are not uncommon. Further, neither site is permitted, so there is no oversight with respect to pond integrity or manure management. Therefore, a recommendation was made to specifically address these sources.

Pump-ins can increase salinity and, possibly, arsenic in the aqueduct. Although salinity is a concern to MWDSC because of its blending program, the associated MCLs were adopted to address problems of taste and odor, not human health. Arsenic is another constituent in pump-ins that DHS has identified as a potential threat to human health.

Approximately one-third of the SLC pump-in samples contained arsenic above 0.005 mg/L with a maximum of 0.032 mg/L. With the current MCL of 0.05 mg/L, these waters do not pose a threat to aqueduct water quality. However, anticipated changes in the law may lower this number to 0.01 or 0.03 mg/L. If this occurs, SLC pump-ins will become a significant source of arsenic.

8.3.6 Watershed Management Practices

The only known watershed management activity west of the SLC is related to abandoned asbestos mines in Arroyo Pasajero. This activity, conducted by the EPA, is briefly described. Following is a review of DWR actions and procedures that are intended to reduce the input of floodwater to the aqueduct. Finally, the canal waste way proposal is described along with an existing structure that may be useful at lowering sediment loads.

8.3.6.1 Abandoned Mine Remediation

The abandoned asbestos mines in the Arroyo Pasajero watershed underwent remediation following a plan that contained 5 main elements (EPA 1994):

1) Run-on/Runoff Control—construction of diversion channels and sediment retention dams to minimize off-site release during storms.
2) Access Restriction—gates and signs to restrict access.
3) Re-vegetation—revegetation of disturbed areas to increase stability of the tailing piles and decrease erosion.
4) Road Maintenance—paving of roads through the area to reduce emissions and protect public health.
5) Mill Demolition—demolition of the mill and debris removal.

The Coalinga Mine and the city of Coalinga Unit were remediated, but the Atlas Mine was not. In 1999, revegetation progress at the Atlas Mine was studied (EPA 1999). From 1996 to 1998, a total of 28 acres were treated, planted, and seeded with more than 10,000 individual plants. The goal was to reduce the off-site movement of airborne and waterborne asbestos. Each phase of planting was increasingly successful. After each planting sequence, the right combination of plant species and soil amendments were identified and applied to the next planting phase. After the 3rd phase, about 75% of all plantings were living and potentially viable. Another 2 to 5 years of unaided growth will be needed before the Atlas Mine could be considered remediated. Regardless of the remediation, the Los Gatos Creek watershed remains a major potential source of asbestos to Arroyo Pasajero.

8.3.6.2 DWR Actions

Project Operating Procedures

A number of SWP operating procedures have been written and amended to address floodwater inflows. These are instructions that codify the operation of specific structures or incidents.

OP-13. The 1st is Project Operations and Maintenance Instruction No. OP-13. This order, last amended in 1993, addresses how all floodwater are to be handled. It has 4 major sections.

1) Make every reasonable effort to prevent or minimize the inflow of floodwater. The actions taken are usually further identified in SWP orders specific to particular floodwater structures (presented next).
2) Measure inflow volumes and provide information to Project Operations Control office, which is responsible for revising pump schedules and gate settings that may be affected by these inflows.
3) Monitor the water quality of floodwater inflows. Grab samples will be collected at drain inlets and ponded water pumped into the aqueduct. Flow measurements will be collected from pump run-time, visual estimates, or stage-discharge curves where available.
4) Coordinate the disposal of floodwater to confine sediment in the SLC to as small an area as possible. Some of the actions include the following: Reduce Dos Amigos pumping to meet San Joaquin Valley demands only; use floodwater to fill Southern California reservoirs; remove floodwater from the SLC via the KRI or other waste ways. These actions are to be coordinated with Project Operations Control.

SLFD-OP-95-8F AND SLFD-0P-97-8G. This standing order outlines the operating procedures of the Arroyo Pasajero floodwater gate structures. It essentially provides a sequence of measures to be taken in order to reduce inflows and protect noneasement property.

1) Use the retention basin north of Gale Avenue to store initial inputs.
2) If water in the 1st basin reaches elevation 328 at Gale Avenue, it will flow south onto private (noneasement) property all the way to Avenal Cutoff Road.
3) If water exceeds elevation 328 after both basins are filled, the evacuation culvert will be opened and water allowed to flow onto private property to the east.
4) If floodwater is predicted to exceed elevation 328 even after the culvert gates have been opened, floodwater will be admitted to the SLC via the inlet gates.

SLFD-OP-91-20E. This standing order dictates the operation of the inlet structure for Little Panoche Creek. The slide gates in front of the inlet are to be manipulated to limit sediment inputs. During initial flows, the slide gates will be closed and water passed under the aqueduct to the east ponding basin. When its capacity is reached, water will be redirected into the west ponding basin in front of the closed inlet gates. When a sufficient amount of sediment has settled in the ponding basin, the slide gates will be lowered to decant floodwater into the aqueduct. Slide gates will be lowered as needed to keep the water in the west ponding basin at a safe level.

LOS BANOS CREEK RETENTION DAM: This dam will provide 14,000 af of space for flood control between September and March. Dam releases are determined by the USACE, and downstream flows are not to exceed 1,000 cfs. The creek's rate of change is not to change by 100 cfs in any 4-hour period, in part because of the capacity of the evacuation culvert under the aqueduct. During spring and summer, reservoir levels are raised for recreation. Although there is an evacuation culvert to pass releases under the aqueduct, a weir was built in 1995 to accept floodwater into the SLC if flow gets high enough.

LITTLE PANOCHE CREEK DETENTION DAM: This dam modulates floodwater from the upstream watershed. It was designed to prevent peak flows from exceeding the capacity of the evacuation culvert on the SLC. Discharge from the outlet works is uncontrolled and will begin when the reservoir surface exceeds 603 feet. Discharges from the spillway are also uncontrolled and will occur when the reservoir levels exceed 642 feet.

Miscellaneous

In March 1992, the pump at mile 74.57 was disconnected. This was a permanent structure installed to pump water from the Billie Wright watershed into the SLC. Water from this watershed is highly saline and contains elevated selenium levels. Now the water flows under the aqueduct through an evacuation culvert. The water eventually passes through orchards to a bypass on the DMC.

During summer 1998, DWR field staff noticed agricultural drainage being pumped into a channel that led to Little Panoche Creek. Staff pointed out to the farm operator that the tail water, mostly from truck crops like strawberries, could flow into the aqueduct and may contain pesticides. The farm operator cooperated by stopping all discharges, and none have been reported since.

Waste way Proposal

A new DWR work plan was proposed in May 2000 to address all floodwater inflow (USACE and DWR 2000). The SLC would be used as a conveyance to transport floodwater to a newly proposed waste way turnout. The proposed turnout, just north of Check 21, could be operated to divert low quality floodwater out of the aqueduct and onto land to the east. The identified land would have to be purchased by DWR for the sole purpose of ponding floodwater. With modifications such as an 11-mile earthen dam, a bridge, and a siphon for an existing water conveyance, the land would serve as a retention basin with a capacity of about 70,000 af.

As opposed to earlier plans that focused on Arroyo Pasajero, this one has the added benefit of addressing (essentially removing) floodwater from all drain inlets including the largest—Cantua Creek. Modifications were also proposed specifically for Arroyo Pasajero; increasing the capacity of the ponding basin and installing a larger drain inlet. This was needed to handle a probable maximum flood scenario. Efforts are under way to investigate this plan in detail; a final feasibility report/EIS/EIR is tentatively scheduled for 2002.

Interceptor Drain Near Dos Amigos Pumping Plant

Starting at mile 83.7 and extending to Dos Amigos Pumping Plant at mile 86.7, an interceptor drain exists on DWR easement property. It intercepts drainage from agricultural fields that flow toward for the aqueduct. Once the drain fills, water can either overflow into the aqueduct or be pumped into another drain. Because of the drain's settling capacity, it provides an efficient means of reducing sediment loads to the aqueduct.

Runoff enters the interceptor drain at the north end (mile 83.7) and flows south. The drain gets progressively larger as it approaches South Mercy Springs Road at mile 85.07. At this point, the drain is about 20 feet wide and 15 feet deep. There are 2 pumps at this location—1 that pumps water to other side of the road and into another easement drain and 1 that pumps water into the aqueduct. The former is used by the landowner for irrigation recirculation purposes, and the latter is owned by DWR. DWR's pump is addressed in OP-350R and called "Open Drain Sump Pump (No 15.1)." The procedures state that this pump is to be used only when the landowner's pump is inoperative.

There is also a 6-by-4-foot drain inlet on the lip of the interceptor drain at mile 85.05. The intake is about 9 feet from the bottom of the drain. Therefore, any runoff large enough to fill the drain to this level would essentially be "decanted" into the aqueduct with presumably lower suspended sediments. Although 13 af was admitted to the aqueduct from this drain in 1998, no accompanying water quality samples were collected. Sediment is periodically removed from the drain to keep it operational, further evidence of its sediment removal capability. The sediment is removed by DWR staff and transported off-site. The existing information indicates that this drain provides a cost-effective means of keeping sediment out of the aqueduct. A recommendation was made to incorporate more of these interceptor drains along the SLC if they are feasible.

8.4 KETTLEMAN CITY TO KERN RIVER INTERTIE

8.4.1 WATER SUPPLY SYSTEM

8.4.1.1 Description of Aqueduct and SWP Facilities

Major facilities that make up section 4 of the California Aqueduct include a 69-mile long canal that extends from the end of the SLC (mile 172.4, below Check 21) to the KRI below Check 28 (mile 241) (Figure 8-20). Water flows by gravity and is not pumped into this section. The Coastal Branch Aqueduct begins at mile 184.63 just below Check 22 (see Chapter 9).

Figure 8-20 California Aqueduct: Kettleman City to Check 41 (Sections 4 and 5)

There is 1 continuous, cement-lined canal section within section 4 of the California Aqueduct, and flow is controlled along the reach with 7 check structures composed of 4 radial gates. The canal is constructed as a siphon under Avenal Gap at mile 184.27 and at Temblor Creek, mile 220.27. The siphons allow floodwater to flow over the aqueduct. As with other sections of the aqueduct, section 4 contains a number of structures built to handle surface water runoff and groundwater inflows that are potential sources of contamination (Table 8-20).

Table 8-20 Description of Structures from South of Avenal to the Kern River Intertie

Type	Number
Drain Inlets	
Canal Roadside Drainage	429
Agricultural Drainage	0
Groundwater	1
Other	5
Bridges	22
State	4
County	11
Farm or private	7
Overcrossings	111
Pipelines	59
Overchutes	52
Undercrossings	12
Drainage	10
Irrigation or domestic water	2
Water service turnouts	39
Irrigation pumped upslope	3
Other	27
Fishing Areas	9

8.4.1.2 Description of Agencies Using SWP Water

There are 6 agencies that receive SWP water in this section. Five of the 6 agencies use the water exclusively for agricultural purposes. The KCWA uses about 11% of its supply for municipal and industrial uses and another 1% for groundwater recharge. The agencies are presented in Table 8-21.

Table 8-21 Agencies Supplied by Section 4 of the California Aqueduct

Agency	Service Area (sq. miles)	Entitlement (acre-feet)
Oak Flat Water District	4,000	5,700
County of Kings	1,081	4,000
Empire West Side Irrigation District	12	3,000
Dudley Ridge Water District	60	53,370
Tulare Lake Basin Water Storage District	296	118,500
Kern County Water Agency	2,152	1,046,730

8.4.2 WATERSHED DESCRIPTION

The region traversed by section 4 of the California Aqueduct is sparsely populated, consisting mainly of crops and rangeland and does not contain watershed such as the SLC nor does it have substantial floodwater inflows.

8.4.3 POTENTIAL CONTAMINANT SOURCES

8.4.3.1 Recreation

The Kettleman City fishing access site is at the Milham Road crossing, just west of Kettleman City, and is very popular with the local people. Eight other fishing areas were identified in *Sanitary Survey 1990* (Brown and Caldwell 1990), but no estimate of user days is available. It is also unknown whether there are trash receptacles accessible to the public at these sites. Lack of such facilities could lead to contamination of the aqueduct with garbage. *Sanitary Survey 1990* reported that only 1 of the fishing sites had portable toilets, which increases the risk that the aqueduct can be contaminated with human waste.

8.4.3.2 Wastewater Treatment Facilities

There are no known wastewater treatment facilities discharging into section 4 of the California Aqueduct.

8.4.3.3 Floodwater Inflows

Water from the Kings River (7,236 af) was admitted to the aqueduct via Westlands Water District pumping facilities to Lateral 7 (mile 115.40) April to June 1998. It originated from the Westlands Water District inlet canal on the Mendota Pool and was composed largely of releases from Sierra Nevada dams for flood control. In typical years, no watershed runoff reaches the aqueduct in this section.

Sanitary Survey 1990 (Brown and Caldwell 1990) reports that there have been instances of overchute culverts overflowing into the aqueduct during periods of high runoff. Additionally, the report mentioned that erosion had occurred in the canal from unlined side slopes. It is unknown whether these deficiencies have been corrected.

8.4.3.4 Accidents and Spills

Interstate Highway 5 and State Highway 41 cross the aqueduct just south of Kettleman City. State highways 46, 58 and 119 cross near Wasco, Buttonwillow, and Bakersfield. There are no reports of accidents or spills flowing into the aqueduct, but storm water drainage from the bridges could contribute accumulated urban pollutants. Two bodies were recovered from this section of the aqueduct between June 1998 and August 1999. Two automobiles were also discovered in this reach of the aqueduct during the same time frame.

In December 1998, the Lost Hills oil fire deposited a light film of oil over a section of the aqueduct at mile 201.5 and extending downstream as far as Check 24. Cleanup efforts included oil booms in the water, which was periodically skimmed by a vacuum truck to remove the oil. The deposition of oil in the aqueduct lasted approximately 3 days. The oil well discharge was diverted after several days so that the plume would not be carried by the wind over the aqueduct. Cleanup efforts on the area continued, and it was reported that the discharge was sufficiently controlled to prevent further impacts on SWP water quality. However, this is still considered a moderate potential contaminate source.

8.4.3.5 Water Service Turnouts

There are 30 water service turnouts to various water districts in section 4 of the California Aqueduct (Brown and Caldwell 1990). Three of the turnouts are pumped, while the other 27 turnouts flow by gravity. No information was available on whether the pump turnouts had backflow prevention devices. Lack of such devices creates the potential for pesticides and nutrients in contaminated surface water to enter the aqueduct, which can pose a moderate threat to water quality.

8.4.4 Water Quality Summary

8.4.4.1 Watershed

There were no water quality data available for this aqueduct section, other than the Lost Hills fire incident, and none of the regularly monitored check stations are in this section. Check 21 is discussed in Section 8.2, The O'Neill Forebay; and Check 29 is discussed in Section 8.5.4.3.

The Lost Hills oil fire at mile 201.5 was the only major water quality problem noted for this section of the aqueduct. Drain inlets and overcrossings probably contribute some pollutants associated with urban runoff, but there were no data or reports on this and it is likely a very minor source.

The oil deposition in the Lost Hills oil fire was sampled to determine the status and extent of contamination. Samples were collected upstream, at the site of the film, and downstream of Check 24. The results showed relatively low TPH levels, ranging from 190 µg/L at the site to 630 µg/L at Check 24 (Joyce pers. comm. 1998). Several samples had levels below detectable limits. No follow-up information on the status of the oil deposition was available.

8.4.4.2 Water Supply System

The KCWA is the only agency in this section of the aqueduct that uses SWP water for municipal, industrial, and domestic use. Whenever possible, Irrigation District 4 trades SWP water for higher quality Kern River water, and uses SWP water solely for irrigation. On the occasions that Kern River water is not available, SWP water is conveyed from the aqueduct through the Cross Valley Canal, and pumped at the treatment plant into a temperature equalizing pond, and then treated by their normal process. No water quality data were available for this water treatment facility, but the KCWA has reported no problems with SWP deliveries.

8.4.5 Significance of Potential Contaminant Sources

There was only 1 significant floodwater inflow to this section of the aqueduct during 1998. Accidents or spills are the only other significant sources of contamination to the aqueduct, although recreational activity could be a potential source of pathogens. The December 1998 Lost Hills oil fire deposited a light film of oil over a section of the aqueduct, which reportedly was cleaned up by oil booms in approximately 3 days.

There is also potential for contamination from highway crossings. Rainfall in this section is sparse. Local runoff from the infrequent rain carries the accumulation of brake dust, tire rubber, and spills from vehicles into the aqueduct, but this is likely a minor threat to water quality.

Overcrossings exist in numerous locations in the form of pipelines and overchutes used to convey runoff across the canals. Materials conveyed in the pipelines include petroleum products, storm drainage, irrigation water, domestic water, and natural gas. If overchutes are designed with insufficient capacity or if sediment accumulation reduce pipeline capacity, floodwater inflows can enter the canal. Depending on the source of the runoff (roadside drainage, agricultural drainage), a number of different contaminants can enter the canal. Relative to the contamination risk to upstream sections of the California Aqueduct such as the SLC, the overall risk of contamination in section 4 is minor.

8.4.6 WATERSHED MANAGEMENT PRACTICES

The aqueduct was dredged in 1996 to remove sediment deposited by floodwater inflows the previous season. Dredging was done with a low-profile cutter head that suctioned material onto land west of the levee. Several locations were dredged between mileposts 157 and 163. Extensive monitoring determined that no substantial changes in aqueduct water quality occurred during the operation. There are no known watershed management activities west of this section of aqueduct. However, routine canal patrols and emergency plans such as discussed in Chapter 11 reduce the potential for discharge of contaminants into the aqueduct.

8.5 KERN RIVER INTERTIE TO EAST/WEST BRANCH BIFURCATION

8.5.1 WATER SUPPLY SYSTEM

8.5.1.1 Description of Aqueduct and SWP Facilities

This 63-mile section of aqueduct starts at mile 241 where the KRI is and ends where the East and West Branches of the California Aqueduct bifurcate at mile 304 below Check 41 (Figure 8-20).

Throughout this section are 4 pumping plants: Buena Vista, John R. Teerink, Ira J. Chrisman Wind Gap, and A. D. Edmonston. The Edmonston Pumping Plant is the largest of these and pumps water almost 2,000 feet over the Tehachapi Mountains into Tehachapi Afterbay at Check 41. From the Tehachapi Afterbay at milepost 303.45, the aqueduct continues another half-mile to the East/West branch bifurcation at milepost 304.

There are a number of over- and undercrossings to pass floodwater to the downslope, or eastern side of the aqueduct, including 23 overchutes and 18 evacuation culverts (Table 8-22). Although there are 10 designated fishing areas, fishing has been observed at numerous undesignated locations. Toe drains convey runoff from adjacent operating roads or road crossings.

Several toe drains convey natural runoff from a small area of adjacent hillside into the Tehachapi Afterbay. Sanitary Survey 1990 (Brown and Caldwell 1990) addressed the significance of most of these features as contaminant sources. The most notable feature in Table 8-22 from a water quality standpoint is the KRI. The KRI is a gated channel designed to convey water into or out of the aqueduct. Inflow from the KRI can occur during the winter when Sierra Nevada runoff threatens to flood agricultural land in the dry lakebeds of Tulare and Buena Vista. This occurred in 2 out of 4 years from 1996 to 1999.

Table 8-22 Major Structures on the Aqueduct, Milepost 241 to 304

Structure	Number
Toe drains for canal operating road and/or canal right of way	327
Bridges	17
Overcrossings	76
Pipelines	53
Overchutes	23
Undercrossings	18
Evacuation culverts	18
Waste way or drain	2
Kern River Intertie	1
Pastoria Creek Drain	1
Siphons	9
Water service turnouts	24
Fishing areas	10
Submersible pumps for relieving canal seepage and/or groundwater pressure against the lining	36

Sources: Brown and Caldwell 1990, DWR 1999a.

Similar inflows (Sierra Nevada runoff) were admitted to the aqueduct from the Cross Valley Canal in 1998. The Cross Valley Canal is a turnout used to make deliveries to KCWA. However, flow is sometimes reversed to alleviate flooding of agricultural land in the Tulare Lakebed. Although this source is upstream of the KRI at milepost 238, it is discussed here because its inflows coincide with KRI inflows.

8.5.1.2 Description of Agencies Using SWP Water

The KCWA uses all 24 turnouts throughout this section of aqueduct. The diverted water is used for a variety of purposes, including agriculture, groundwater recharge, and municipal/industrial. Most of the water taken for municipal/industrial use during 1998 was diverted between mileposts 241 and 243 and 282 and 293 (DWR 1999d).

8.5.2 WATERSHED DESCRIPTION

Section 5 of the aqueduct traverses the southern San Joaquin Valley and Tehachapi Mountains of Southern California. The dominant land use in this region of the San Joaquin Valley is cropland and rangeland. The Tehachapi Mountains are generally aligned near east-west and form the southern end of the Sierra Nevada. The range is composed of granitic rocks with limited areas of pre-batholith metamorphic outcrops. Elevation ranges from about 3,500 feet up to 7,981 feet. The predominant natural plant communities are Blue oak, singleleaf pinyon, and canyon live oak; mixed chaparral shrublands are common on shallow soils. There are some Ponderosa pine, Jeffrey pine and White fir in the higher elevations. Black oak and Valley oak are common on mountain footslopes and in valleys of the Tehachapi Mountains.

8.5.3 POTENTIAL CONTAMINANT SOURCES

Sanitary Survey 1990 addressed several PCSs to this section of aqueduct, including bridges, overcrossings, water service turnouts, fishing, and accidental spills. However, the largest PCSs are inflows from the KRI, Cross Valley Canal, and groundwater pump-ins. Following is a general description of these 3 as well as miscellaneous PCSs.

8.5.3.1 Kern River Intertie

The KRI is a gated channel designed to convey water into, or out of, the aqueduct. It is used mostly to convey water into the aqueduct to relieve flooding east of the aqueduct. Inflow from the KRI can occur during the winter when Sierra Nevada runoff threatens to flood agricultural land in the dry lakebeds of Tulare and Buena Vista. Flood-flows from the Kern River pass through a siltation basin and then into the aqueduct at milepost 241, approximately 3 miles above Check 29. A more detailed description of the Kern River watershed and PCSs can be found in previous sanitary surveys. The KRI is a significant potential source of turbidity and is considered a moderate threat to water quality.

Between 1996 and 1999, water from the KRI was admitted to the aqueduct on 2 occasions (Table 8-23). In 1997 inflows totaled 52,858 af and occurred between 9 January and 26 February. The following year, 188,048 af of KRI water entered the aqueduct. During both inflow events, most of the water sent down the aqueduct was from this source (DWR 1999b and 2000).

During 1998, 10,398 af of water was also admitted to the aqueduct via the Cross Valley Canal (milepost 238.04, just prior to Check 28), which is a turnout used to make deliveries to KCWA. In 1998 water was pumped from the canal into the aqueduct to alleviate flooding of agricultural land in the Tulare Lakebed. Cross Valley Canal inflows originated from the Tule and Kaweah rivers and were sent to the aqueduct via the Friant-Kern Canal. Water quality of inflows from the Cross Valley Canal and KRI is described in Section 8.5.4, Water Quality Summary.

Table 8-23 Inflow to the Aqueduct from the Kern River Intertie, 1996 to 1999

Year	Period	Avg Flow	Total Volume
1997	9 Jan – 26 Feb	550 cfs	52,858 af
1998	3 Apr – 8 Jul	977 cfs	188,048 af

8.5.3.2 Groundwater Discharges

Groundwater can be pumped into the aqueduct from DWR sump pumps that protect the canal liner. There are 36 of these in this section of aqueduct (Table 8-22). As with sump pumps located in the SLC, no quantity or quality information was available.

Groundwater can also originate from any of the 24 water service turnouts (DWR 1994). Groundwater underlying land east of the aqueduct can be conveyed into the aqueduct via these turnouts in return for an equal amount of SWP water returned at another time and place than the original pump-in. Pump-ins mitigate for supply deficiencies imposed on federal water contractors, usually during drought periods. Although there were no pump-ins from 1996 to 1999, they remain a potential source of salinity and arsenic.

Pump-ins within this section of the aqueduct have higher levels of TDS and arsenic than aqueduct water. More than half of the pump-in samples collected between mileposts 241 and 304 contained arsenic higher than 0.005 mg/L (the mean) with a range of <0.001 to 0.010 mg/L (DWR 1994). TDS ranged from 549 to 1140 mg/L with an average of 763 mg/L. Therefore, pump-ins are a source of TDS and arsenic to the aqueduct. A new policy regarding future pump-ins has been negotiated.

8.5.3.3 Recreation

There are 10 designated fishing areas, but fishing activity has been observed at numerous undesignated locations. There is no contact recreation allowed in the aqueduct. However, human waste and trash associated with these activities are considered a moderate potential source of pathogens.

8.5.3.4 Accidents/Spills

In June 1999, two oil releases were reported at Chrisman Pumping Plant. On the 1st occasion, approximately 280 gallons of hydraulic oil were released into the number 1 discharge line. The line was drained back, and the oil removed. A similar release occurred later that month involving 15 to 20 gallons. On this occasion, booms were placed in the aqueduct to contain and recover the oil.

Several other potentially contaminating accidents/spills took place from 1996 to 1999. The 1st occurred when a blacktop roller tipped over in the aqueduct. The 2nd occurred in 1999 when a fuel tank went into the aqueduct after a truck accident on the Interstate 5 crossing about 8 miles upstream from the Edmonston Pumping Plant. An oil sheen was observed in the pumping plant's forebay and determined to have come from the accident. Information from the truck owner indicated the tank contained 15 to 20 gallons of diesel fuel. DFG divers were unable to locate the tank. Oil booms were used to remove the fuel in the forebay. A 3rd incident involved a truck that was observed dumping mulch and paper debris into the aqueduct near the Sunset Railroad siphon (approximately milepost 260). This is considered a moderate potential source of hydrocarbons in the aqueduct.

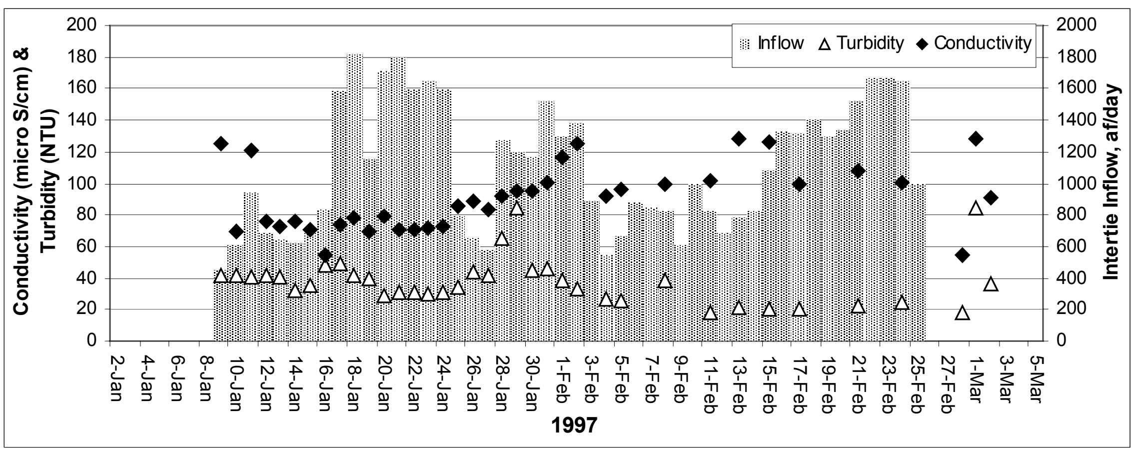
8.5.4 WATER QUALITY SUMMARY

A water quality assessment of the KRI and Cross Valley Canal is followed by a review of water quality in the aqueduct at Check 29 and Check 41.

8.5.4.1 Kern River Intertie

Low salinity and relatively moderate turbidity characterizes the water quality of inflows from the KRI. During the 1997 inflow event, daily conductivity ranged from 55 to 128 µS/cm with an average of 91 µS/cm (Figure 8-21). Similar levels were measured downstream in the aqueduct at Check 29 and Check 41 soon after the KRI gates were opened (DWR 1999b). Turbidity in the KRI ranged from 18 to 85 NTUs with an average of 37 NTUs. Downstream turbidity in the aqueduct generally following KRI trends but at lower levels.

Figure 8-21 Conductivity, Turbidity, and Volume of Kern River Intertie Inflows, 1997



Laboratory analyses of the 1997 KRI inflows showed low mineral levels, TOC levels of 4.0 and 4.9 mg/L in 2 samples, and arsenic levels between 0.002 and 0.003 mg/L (Tables 8-24 and 8-25). A complete metals scan detected low levels of iron. All other metals were below the reporting limit. A single sample collected for organic chemicals contained diuron at 0.39 ppb and simazine at 1.41 ppb (Table 8-26). Although bromide was not analyzed in KRI inflows, downstream levels in the aqueduct dropped to <0.01 mg/L at Devil Canyon Afterbay in February 1997, coinciding with the period of inflow (DWR 1999b).

Table 8-24 Major Minerals and Conventional Parameters in the Kern River Intertie and Cross Valley Canal, 1997 to 1998 (mg/L unless otherwise stated)

	Kern River Intertie						Cross Valley Canal	
	9 Jan 1997	13 Jan 1997	28 Jan 1997	11 Feb 1997	6 Apr 1998	14 Apr 1998	6 Apr 1998	14 Apr 1998
Bicarbonate ($CaCO_3$)	33	32	40	44	63	64	57	66
pH	6.8	6.7	7.0	7.0	7.9	7.9	7.6	7.9
Sulfate	4	4	4	6	9	9	9	9
Chloride	2	3	3	3	4	4	4	6
Nitrate (as NO_3)	1.3	1.1	1.7	1.2	2.2	1.8	3.7	2.5
Fluoride	<0.1	<0.1	<0.1	0.1	0.1	0.2	<0.1	0.1
Boron	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Total Organic Carbon	4.9	4.0				4.5		4.1
Suspended Solids (Tot.)	29	28	47	17	29	56	88	28
Suspended Solids (Vol.)	2	6	6	6	6	6	11	4
Turbidity (NTU)		23	31	12	58	38	85	24
TDS	66	61	72	80	110	102	102	124
Conductivity (micro S/cm)	89	80	103	115	161	166	155	176
Hardness (as $CaCO_3$)	28	28	33	36	57	59	54	59
Calcium	8	8	10	11	16	17	15	17
Magnesium	2	2	2	2	4	4	4	4

Table 8-25 Minor Elements in the Kern River Intertie and Cross Valley Canal, 1997 and 1998 (mg/L)

	Sample Dates							
	Kern River Intertie						Cross Valley Canal	
	9 Jan 1997	13 Jan 1997	28 Jan 1997	11 Feb 1997	6 Apr 1998	14 Apr 1998	6 Apr 1998	14 Apr 1998
Arsenic	0.003	0.002	0.002	0.003	0.004	0.004	0.002	0.002
Barium	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050
Aluminum	<0.010	0.010	<0.010	0.010	<0.010	<0.010	<0.010	<0.010
Zinc	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Silver	<0.005	<0.005	<0.005	<0.005	<0.001	<0.001	<0.001	<0.001
Selenium	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Mercury	<0.0010	<0.0010	<0.0010	<0.0010	<0.0002	<0.0002	<0.0002	<0.0002
Manganese	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Lead	<0.005	<0.005	<0.005	<0.005	<0.001	<0.001	<0.001	<0.001
Iron	0.020	0.021	0.017	0.023	0.018	0.016	0.010	0.008
Copper	<0.005	<0.005	<0.005	<0.005	0.003	0.002	0.006	0.002
Chromium	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Cadmium	<0.005	<0.005	<0.005	<0.005	<0.001	<0.001	<0.001	<0.001

Table 8-26 Organic Chemicals Detected in the Kern River Intertie [a]

	Sample Date	
	16 Jan 1997	6 Apr 1998
EPA 608 Scan (Chlorinated Organics)		ND
Diruon	0.39	
Simazine	1.41	
EPA 614 Scan (Organo-Phosphorus Pesticides)	ND	ND
EPA 615 Scan (Chlorinated Phenoxy Acid Herbicides)	ND	ND
EPA 602 Scan (Purgeable Organics)	ND	ND
EPA 547 Scan (Glyphosate, Propargite)	ND	ND
EPA 531.1 Scan (Carbamates)	ND	ND

[a] µg/L, ND = None Detected

Table 8-27 Pathogens in Kern River Intertie Inflows, 19 Jan 1997

Pathogen	Units	Concentration
Fecal Coliforms	MPN/ 100 mL	220
Total Coliforms	MPN/ 100 mL	1,600
Giardia	# Cysts/ 100 L	73
Cryptosporidium	# Oocysts/ 100 L	10.4

One pathogen sample was collected for coliforms, *Giardia cysts*, and *Cryptosporidium oocysts* (Table 8-27). Pathogen data are discussed in Chapter 12.

During 1998, water from both the Cross Valley Canal and KRI was admitted to the aqueduct. Conductivity in the KRI ranged from 63 to 170 µS/cm with an average of 104 µS/cm. Conductivity was higher in the Cross Valley Canal with 2 of the 8 values increasing to 525 µS/cm (Figure 8-22). However, the high level measurements were on days with no inflow. On 20 April and 30 April, conductivity was 521 and 525 µS/cm, respectively. These levels were unusual because conductivity was rarely above 200 µS/cm in either the Cross Valley Canal or KRI. Although there was no inflow on those days, there were several days surrounding those dates where inflows occurred with no conductivity measurements. The automated monitoring station at Check 29 indicated a multiday rise in conductivity corresponding with the 20 April and 30 April dates (DWR 1998). Therefore, Cross Valley Canal inflows with elevated conductivity appear to have affected aqueduct water quality.

The cause of the high Cross Valley Canal conductivity remains unknown. Staff from the KCWA was contacted but provided no explanation. Possible explanations include side drains on the Friant-Kern Canal that take in runoff from adjacent farmland. Groundwater pump-ins could have been made to the Cross Valley Canal. Regardless, the higher salinity indicates that water other than Sierra Nevada runoff such as with the KRI had entered the Cross Valley Canal.

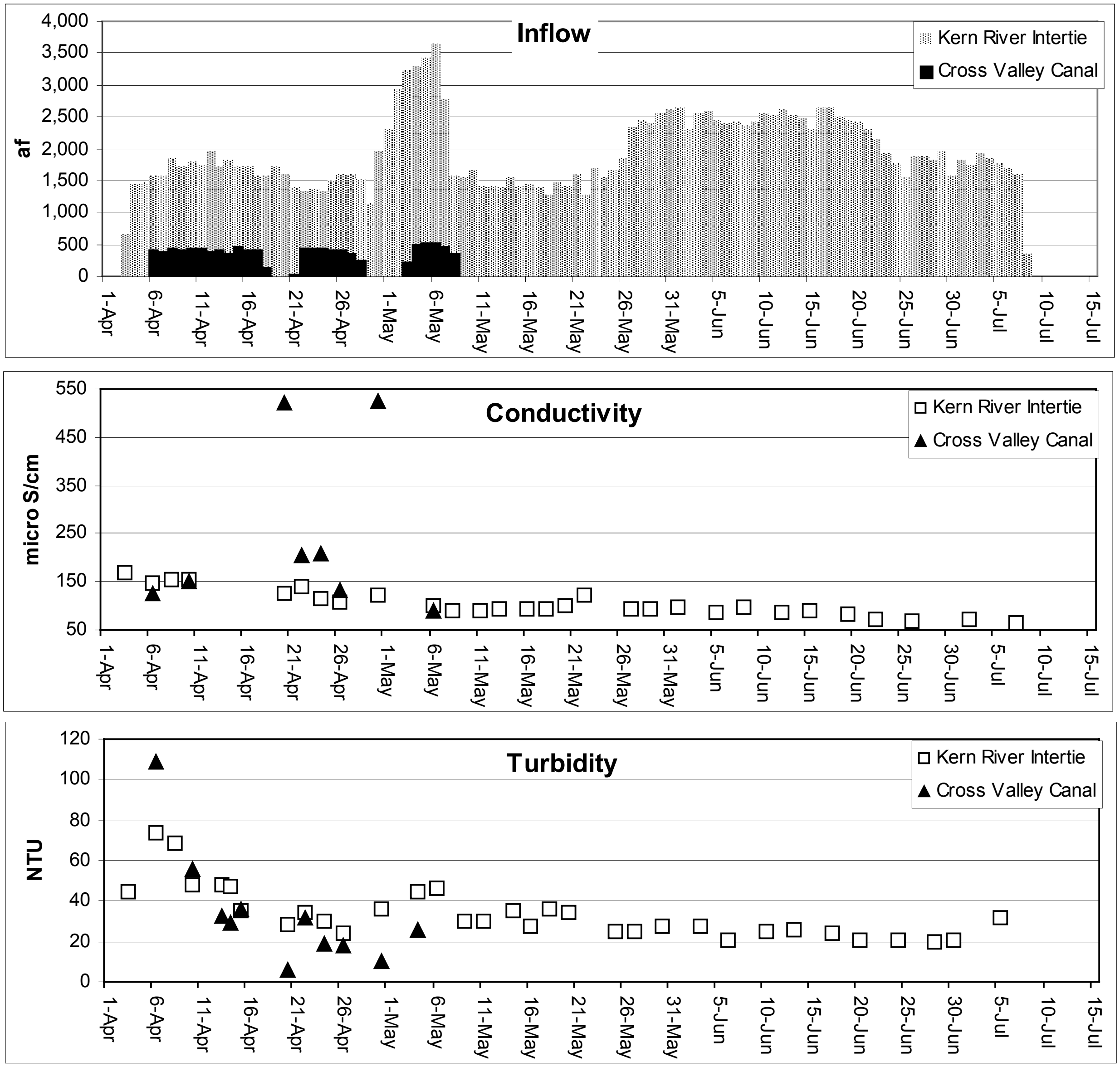
Turbidity in both sources was highest during the 1st week of inflow. For the KRI, turbidity during the 1st week ranged from 45 to 74 NTUs and then tapered off to between 20 and 45 NTUs for the rest of the inflow period (Figure 8-22). A similar trend was observed for the Cross Valley Canal. Note that the lowest levels in the Cross Valley Canal were measured when conductivity was highest. However, as explained, there had been no inflow on those days, and the low turbidities may be due to particulates settling out in calm water.

Laboratory analyses of both inflows during 1998 showed low mineral levels, organic carbon concentrations of 4.1 and 4.5 mg/L in 2 samples, and arsenic ranging between 0.002 and 0.004 mg/L (Tables 8-24 and 8-25). With the exception of low levels of copper and iron, no other metals were detected in the 1998 inflows. No organic chemicals were detected (Table 8-26). Bromide was not analyzed in the inflows; however, downstream levels in the aqueduct at Check 41 ranged from 0.010 to 0.012 mg/L between April and June, corresponding with the period of inflow (discussed next).

8.5.4.2 California Aqueduct

This section of the aqueduct has 2 routine monitoring stations, Check 29 and Check 41. A complete water quality assessment has already been performed on these stations for 1996 through 1999 (DWR 1999b and 2000). A review of select drinking water parameters appears below along with any important observations.

Figure 8-22 Conductivity, Turbidity, and Volume of the Kern River Intertie and Cross Valley Canal Inflow

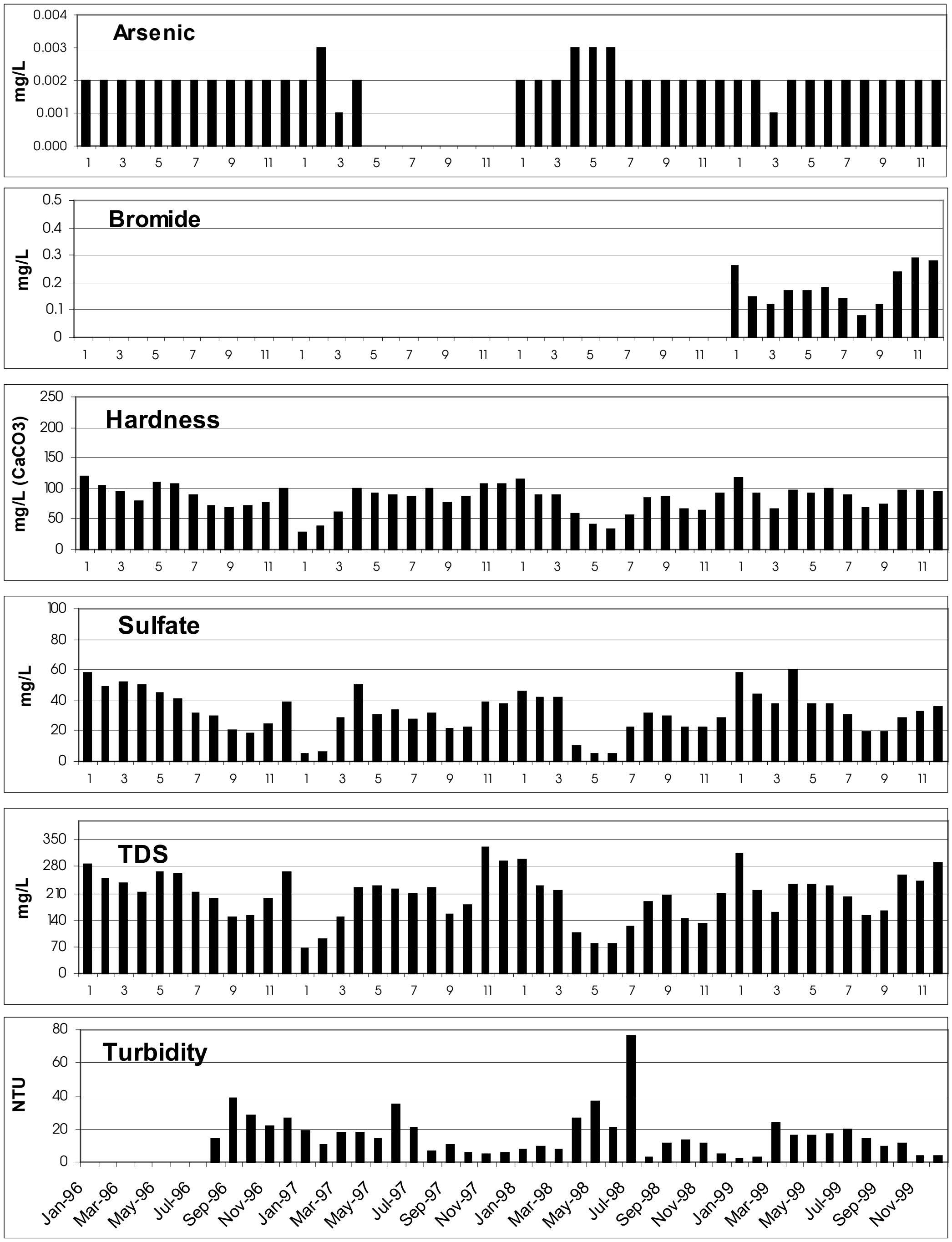


8.5.4.3 Check 29

Check 29 is downstream from the Cross Valley Canal and KRI at mile 244.54. None of the water quality data collected from 1996 to 1999 exceeded any primary or secondary MCLs (DWR 1999b and 2000). Organic chemical analyses during 1996 showed low levels (at or below 1 ppb) of 2,4-D, cyanazine diazinon, dacthal, diuron, and simazine. During 1997 only 2,4-D, cyanazine, and simazine were detected. No organic chemicals were detected at this station in either 1998 or 1999.

Arsenic levels were usually between 0.001 and 0.002 mg/L during the 4-year period and increased to 0.003 mg/L only from April to June 1998 when KRI water dominated aqueduct flow (Figure 8-23). Bromide data were limited because monitoring only began in 1999. TOC is not monitored at Check 29.

Figure 8-23 Water Quality on the California Aqueduct, Check 29



TDS, hardness, and sulfate declined to unusually low levels at Check 29 when water from the KRI was admitted to the aqueduct in both 1997 and 1998. Sulfate went from 39 mg/L in December 1996 to 5 mg/L the following month in 1997. TDS and hardness also declined in January 1997. The same trend occurred the following year from April to June. The declines were largely the result of Sierra Nevada inflows from the KRI, as discussed above.

Turbidity at Check 29 ranged between 2 and 76 NTUs from 1996 to 1999 (Figure 8-23). The high value of 76 NTUs was measured in July 1998, well after KRI inflows had ceased, and was likely due to the resumption of summer flow through the SLC and the corresponding resuspension of sediment discharged by Diablo Range floodwater 5 months earlier. Sediments deposited during low aqueduct flow in winter can be resuspended during summer when demand increases along with the scouring effects of increased flow. An even higher turbidity value was measured that same month farther downstream at Check 41.

8.5.4.4 Check 41

Check 41 is at mile 303.41, just above the bifurcation of the East and West Branches of the California Aqueduct. None of the water quality data collected from 1996 to 1999 exceeded any primary or secondary MCLs (DWR 1999c and 2000). Similar to Check 29, low levels (at or below 1 ppb) of 2,4-D, cyanazine diazinon, dacthal, diuron, and simazine were detected at this station during 1996. The following year, only cyanazine was detected (at the reporting limit of <0.01 ppb in March 1999). No organic chemicals were detected at this station in either 1998 or 1999.

Arsenic at this station was 0.002 mg/L for most of the 4-year period (Figure 8-24). TOC ranged from 2.2 to 9.3 mg/L. Two values of more than 8 mg/L were detected during 1996 to 1999. The 1st occurred when a concentration of 8.1 mg/L was measured in July 1996. No non-SWP inflows occurred that month. Unusually, trihalomethane formation potential (THMFP) was not correspondingly high in the same sample (DWR 1999b). A similar event occurred in January 1999 when TOC was detected at 9.3 mg/L and THMFP was not correspondingly elevated. No explanation could be provided (DWR 2000).

Similar to Check 29, Check 41 was positively affected by the KRI inflows during 1997 and 1998. In February 1997 hardness, sulfate, and TDS declined to some of the lowest levels measured during the 4-year period and coincided with the period of KRI inflow (Figure 8-24). The following year, these inflows occurred again for a 3-month period from April to July, and minerals at Check 41 declined correspondingly. Bromide decreased to 0.010 to 0.012 mg/L, representing some of the lowest salinity ever measured in the aqueduct (mineral data for 2 of the 3 months were missing).

8.5.5 SIGNIFICANCE OF POTENTIAL CONTAMINANT SOURCES

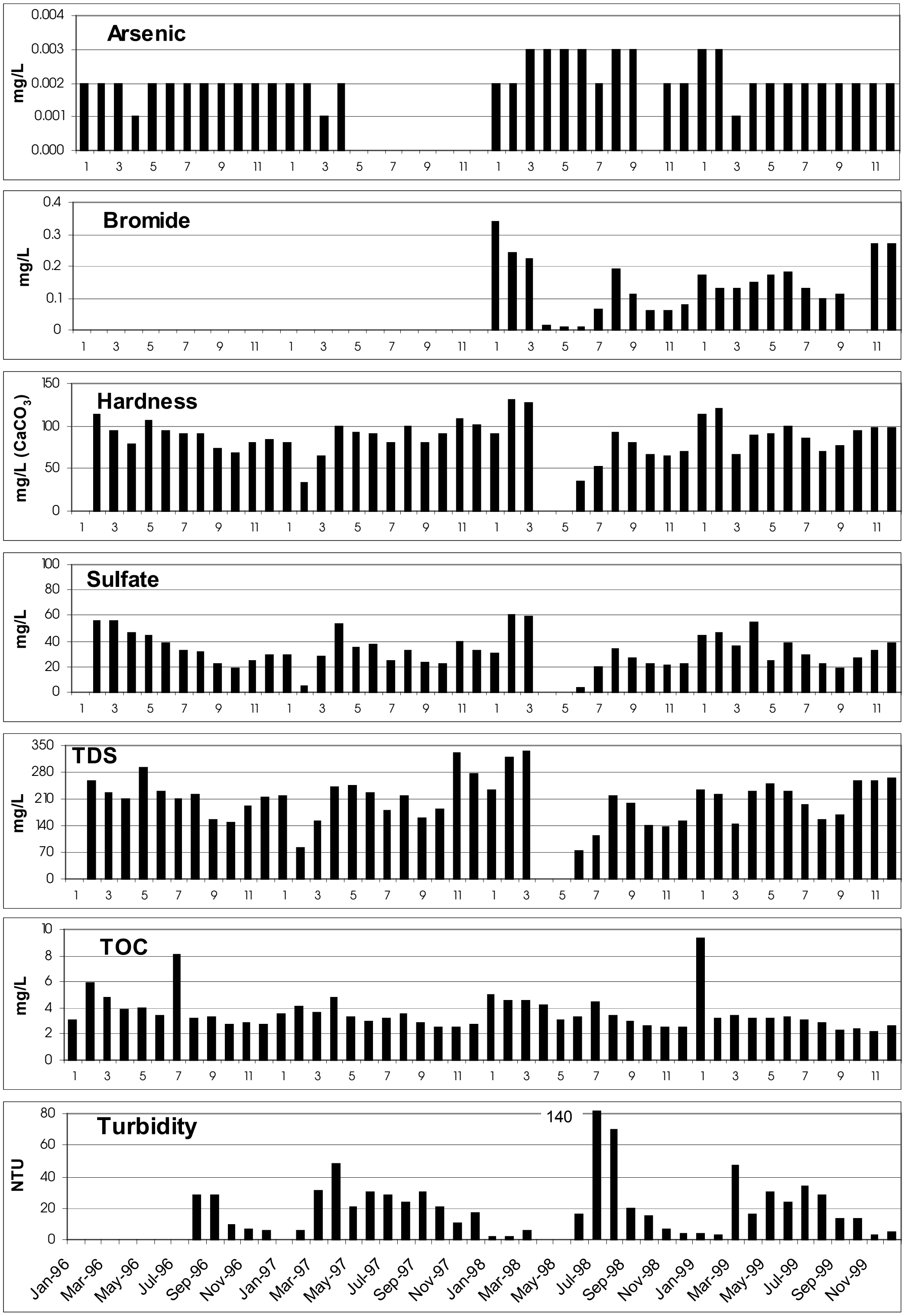
Sanitary Survey 1990 addressed the significance of several features in this section of aqueduct, including bridges, overcrossings, water service turnouts, fishing, and accidental spills. However, the largest source of non-SWP inflow to this section is from the KRI, Cross Valley Canal (just upstream of KRI), and groundwater pump-ins. Their significance with respect to potential contaminants in inflows is discussed here.

8.5.5.1 Kern River Intertie

During 1997 and 1998 the KRI contributed a substantial amount of water to the aqueduct. In 1998 for instance, KRI inflow totaled 188,000 af while floodwater from the Diablo Range totaled 21,000 af. KRI inflow made up most of the water sent down the aqueduct for more than a month during 1997, and almost 3 months during 1998 (DWR 1999b and 2000). Therefore, the KRI was a significant source of water to the aqueduct during those years. With regards to water quality, the KRI appears to provide a net benefit to the aqueduct, specifically with respect to salt and salt-related potential contaminants. The only exception to this is for turbidity, which is considered a moderate threat to water quality.

KRI inflows are of high quality with respect to most drinking water parameters. The inflows resulted in some of the lowest salinity and bromide levels ever measured in the aqueduct. A limited number of TOC samples collected from the KRI were consistently between 4 and 5 mg/L. Although levels in the aqueduct have been lower than this, KRI inflows occur during—or and in the case of 1998 right after—winter when TOC in Delta exports can be as high or higher. Therefore, KRI inflows would contribute to levels already in the same range and may actually provide some dilution when TOC in Delta exports is higher. KRI arsenic levels were sometimes higher than those commonly detected in the aqueduct, but were well below the MCL of 0.05 mg/L.

Figure 8-24 Water Quality on the California Aqueduct, Check 41



Sanitary Survey 1990 identified oil fields and urban runoff from Bakersfield as pollutant sources to the Kern River and, hence, the aqueduct from KRI inflows. Two extensive pollutant scans did not indicate any signs of pollution related to these 2 potential sources: elevated metals and hydrocarbons. Although urban runoff may have commingled with Kern River water, the higher river volumes would have provided heavy dilution. Further, most pollutants associated with urban runoff and oil fields (metals, general hydrocarbons such as polycyclic aromatic hydrocarbons, and organo-chlorine pesticides) are tightly associated with sediment and would move through the system as bedload or suspended sediment. Therefore, the significance of this PCS, in relation to others, would be considered minor. With the exception of turbidity, the net benefit to water quality in the aqueduct would appear to offset any potential problems.

Cross Valley Canal inflows would also appear to provide a net benefit to aqueduct water quality. Although data on its water quality are limited, inflow volumes were relatively minor compared to those from the KRI.

Pump-ins can increase salinity and, possibly, arsenic in the aqueduct. Although salinity is a concern to MWDSC because of its blending program, the MCLs associated with salinity were adopted to address problems with taste and odor, not human health. Arsenic in pump-ins is identified as a potential human health threat.

More than half of the pump-in samples collected between mileposts 241 and 304 contained arsenic above 0.005 mg/L with a maximum of 0.010 mg/L. With the MCL at 0.05 mg/L, these waters do not pose a threat to aqueduct water quality. However, anticipated changes in the law may lower the MCL to 0.01 or 0.03 mg/L. If this occurs, SLC pump-ins may be a significant source of arsenic.

8.5.6 WATERSHED MANAGEMENT ACTIVITIES

Other than floodwater from the KRI and Cross Valley Canal, there are no watersheds draining directly to this section of aqueduct. There are, however, several structures on the aqueduct designed to capture bedload sediment. The aqueduct was designed with sediment traps in the forebays of both Buena Vista and Teerink pumping plants. Their design is described in DWR Bulletin 200 (DWR 1974):

> "Sediment traps upstream of the pumping plant forebays are comprised of 3 cells on each side of the centerline beneath the aqueduct invert. The traps are rectangular in shape, 6 feet deep, 48 feet long, and 11 feet 3 inches wide. Lengthwise, the trap is partially open to the flow and is divided into 3 sections. The 1st quarter is open without any restrictions, the 2nd quarter is covered with a grizzly of 3-inch channels of 8-inch centers perpendicular to the flow and the final half of the trap is covered with 6-inch concrete slabs. Since the need for sediment removal was expected to occur infrequently, no provision was made in the design for hydraulic or mechanical removal of sediments contained by the traps. Sediment removal will be done by maintenance forces using portable equipment."

A sediment trap was also installed between Teerink and Edmonston pumping plants at about mile 292. DWR has historically removed sediment from other locations in the aqueduct using hydraulic dredging techniques (DWR 1997).

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